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Carbon Monoxide Hot Spot Guidelines
Volume III: Workbook

GCA Corp.
Bedford, MA

Prepared for

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Research Triangle Park, NC

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Carbon Monoxide Hot Spot Guidelines

Volume III: Workbook

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16. ABSTRACT

This report presents a summary of the guidelines for the identification and evaluation of localized violations of carbon monoxide air quality standards in the vicinity of streets and highways. The guidelines are provided to facilitate the rapid and efficient review of CO conditions along existing roadway networks, without the need for extensive air quality monitoring, and are based upon the use of limited traffic data. Two stages of review are provided for. Preliminary screening, performed with simple nomographs included herein, simply identifies those locations with the potential to violate CO standards; no quantitative estimate of CO concentrations results from preliminary screening. Verification screening, using procedures and forms provided herein, allows for consideration of additional site-specific conditions and provides quantitative estimates of maximum CO concentrations. Both screening procedures are performed manually and are based upon the EPA Indirect Source Review Guidelines. Data collection procedures, computation techniques, and forms are recommended, and examples are provided. A more comprehensive explanation of the guidelines in terms of their development, technical basis, capabilities and limitations is provided in Volume I.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Atmosphere Contamination Control Atmospheric Models Carbon Monoxide Exhaust Gases Traffic Engineering Transportation/Urban Planning	Air Pollution Model Automobile Exhaust Highway Corridor Air Quality Analysis Relationships between Traffic and Nearby Air Quality	13/13B

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Errata for EPA-450/3-78-035
Carbon Monoxide Hot Spot Guidelines
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1. Page 34-35. The absicca is in "hundreds" of vehicles.

2. Page 50-51. All references to Figure "1-B" should be "1-D."

3. Page 103-105. Replace all of Table 8 with the attached Table 8.

4. Page 126. Step 16 should be Step 17, Step 17 should be Step 18, Step 18 should be Step 19, and Step 19 should be Step 16.

5. Page 126-127. Correct the following steps in the worksheet to reflect corrected numerical values:

Step 13	1.15	1.15	1.15	1.15
Step 14a	3.6			
Step 14b	0.7			
Step 15	4.3			
Step 16	0.82	0.82	0.82	0.82
Step 17	0.0159			
Step 20	6.4	1.9	0.6	0.3
Step 21	9.2			
Step 22	13.5			
Step 23	9.5			
Step 24	2.9			
Step 25	12.4			
Step 26	10.8			

6. Page 129. Line 6, change 2.85 to 1.41. The equation given for C_{Ef} should read:

$$C_{Ef} = (0.78)(0.83) + (0.11)(1.41) + (0.06)(5.23) + (0.05)(0.6) = 1.15$$

In the numerical solution for $X_{f,\ main}$ and $X_{f,\ cross}$ the emission correction factor should be changed from 1.33 to 1.15, thus yielding concentration estimates of 3.6 mg/m^3 and 0.7 mg/m^3 respectively. The total concentration then, X_f, should be $3.6 + 0.7 = 4.3\ mg/m^3$.

7. Page 130. First paragraph, the excess emissions correction factor should be 0.82.

The numerical solution for Q_e should be:

$(0.02297)(0.82) - (0.00251)(1.15) = 0.0159$

8. Page 131. All concentrations given are incorrect and corrections are here given by line number.

Line 1	9.2 mg/m^3
Line 3	4.3 + 9.2 = 13.5 mg/m^3
Line 4	13.5 mg/m^3
Line 6	9.5 mg/m^3, 9.5 mg/m^3
Line 9	12.4 mg/m^3
Line 10	12.4 mg/m^3, 10.8 ppm
Line 15	12.4 mg/m^3, 10.8 ppm

9. Page 114, point (iv), line 3, change "Table 9" to "Table 5."

10. Page 119, point (b), line 2, change "Table 9" to "Table 5."

```
EMISSION CORRECTION FACTORS FOR REGION: LOW ALTITUDE

         YEAR: 1978 1978 1978 1978 1980 1980 1980 1980 1982 1982 1982 1982
        SPEED:    0   15   30   45    0   15   30   45    0   15   30   45
M**  H  C  T-----------------------------------------------------------------

LDV 20 10 20 1.22 1.30 1.37 1.42 1.00 1.11 1.17 1.22  .74  .81  .87  .93
    20 10 40 1.12 1.19 1.23 1.26  .91  .97 1.04 1.08  .67  .75  .79  .82
    20 35 20 1.94 2.17 2.39 2.59 1.64 1.88 2.09 2.25 1.25 1.43 1.59 1.72
    20 35 40 1.57 1.74 1.90 2.03 1.31 1.47 1.63 1.76 1.00 1.13 1.25 1.35
    20 60 20 2.65 3.03 3.42 3.74 2.29 2.66 3.00 3.29 1.75 2.03 2.29 2.51
    20 60 40 2.03 2.30 2.57 2.81 1.72 1.98 2.23 2.43 1.33 1.52 1.71 1.87

LDT 20 10 20 1.38 1.52 1.67 1.76 1.43 1.50 1.59 1.67 1.25 1.42 1.52 1.60
    20 10 40 1.37 1.46 1.53 1.59 1.32 1.37 1.44 1.51 1.15 1.28 1.36 1.42
    20 35 20 2.40 2.56 2.82 3.05 2.19 2.46 2.73 2.95 1.97 2.18 2.45 2.67
    20 35 40 2.01 2.11 2.31 2.40 1.93 2.00 2.20 2.37 1.61 1.90 2.10 2.26
    20 60 20 3.21 3.53 3.97 4.35 2.95 3.42 3.86 4.23 2.69 3.35 3.79 4.15
    20 60 40 2.55 2.76 3.07 3.38 2.33 2.63 2.96 3.23 2.04 2.51 2.83 3.10

MC  20 10 20  .47  .81  .93 1.02  .38  .67  .72  .77  .30  .54  .57  .60
    20 10 40  .42  .73  .83  .92  .34  .57  .64  .68  .27  .48  .50  .52
    20 35 20  .78 1.36 1.55 1.71  .63 1.17 1.31 1.43  .51  .98 1.08 1.17
    20 35 40  .62 1.08 1.23 1.35  .50  .91 1.01 1.10  .40  .75  .82  .89
    20 60 20 1.09 1.90 2.17 2.40  .89 1.59 1.80 2.00  .72 1.41 1.60 1.75
    20 60 40  .81 1.42 1.62 1.79  .66 1.23 1.39 1.52  .53 1.02 1.15 1.26

         YEAR: 1978 1978 1978 1979 1980 1980 1980 1980 1982 1982 1982 1982
        SPEED:    0   15   30   45    0   15   30   45    0   15   30   45
M    H  C  T-----------------------------------------------------------------

LDV 20 10 60 1.05 1.10 1.14 1.16  .85  .92  .96  .99  .63  .70  .74  .76
    20 10 90 1.01 1.05 1.08 1.10  .81  .88  .91  .93  .60  .67  .70  .72
    20 35 60 1.30 1.46 1.59 1.69 1.11 1.24 1.35 1.44  .85  .95 1.05 1.12
    20 35 90 1.19 1.28 1.38 1.46  .98 1.08 1.18 1.25  .75  .84  .92  .98
    20 60 60 1.63 1.83 2.04 2.21 1.37 1.56 1.75 1.90 1.07 1.21 1.36 1.48
    20 60 90 1.37 1.52 1.68 1.82 1.15 1.30 1.45 1.57  .90 1.02 1.14 1.24

LDT 20 10 60 1.30 1.37 1.43 1.48 1.25 1.29 1.34 1.40 1.08 1.19 1.26 1.31
    20 10 90 1.24 1.31 1.36 1.40 1.21 1.23 1.28 1.33 1.04 1.14 1.20 1.24
    20 35 60 1.75 1.90 1.96 2.10 1.58 1.70 1.86 1.99 1.39 1.60 1.75 1.88
    20 35 90 1.56 1.59 1.72 1.83 1.42 1.50 1.63 1.74 1.24 1.41 1.54 1.64
    20 60 60 2.10 2.29 2.50 2.72 1.91 2.12 2.37 2.58 1.69 2.00 2.24 2.44
    20 60 90 1.77 1.97 2.08 2.26 1.62 1.78 1.98 2.15 1.44 1.68 1.87 2.03

MC  20 10 60  .39  .67  .77  .84  .31  .54  .58  .61  .24  .43  .44  .46
    20 10 90  .37  .63  .72  .79  .29  .50  .53  .56  .23  .40  .40  .41
    20 35 60  .50  .87  .99 1.10  .40  .72  .79  .86  .31  .58  .63  .68
    20 35 90  .42  .73  .83  .91  .33  .58  .63  .68  .25  .46  .50  .52
    20 60 60  .61 1.07 1.22 1.35  .49  .90 1.01 1.10  .39  .74  .82  .90
    20 60 90  .47  .82  .93 1.03  .36  .66  .74  .80  .28  .53  .59  .63

HDG          1.72 5.80 5.51 6.34 1.73 6.54 5.62 6.56 1.73 5.23 5.77 6.91

HDD           .71  .62  .60  .62  .71  .60  .57  .57  .73  .60  .55  .53
```

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy duty diesel.

Table 8. Emission correction factors for region, calendar year, speed, percent cold starts (C), percent hot starts (H), and temperature (T) by vehicle type (M).

EMISSION CORRECTION FACTORS FOR REGION: LOW ALTITUDE

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
V**	H	C	T												
LDV	20	10	20	.47	.52	.57	.60	.38	.40	.44	.46	.31	.30	.33	.35
	20	10	40	.43	.47	.51	.54	.35	.37	.40	.42	.29	.28	.31	.32
	20	35	20	.95	.99	1.04	1.13	.71	.77	.81	.88	.61	.57	.64	.69
	20	35	40	.69	.75	.84	.90	.59	.60	.67	.73	.52	.49	.55	.60
	20	60	20	1.22	1.33	1.50	1.65	1.03	1.04	1.19	1.30	.90	.83	.94	1.04
	20	60	40	.94	1.03	1.16	1.27	.84	.84	.95	1.04	.75	.70	.79	.87
LDT	20	10	20	.97	1.19	1.27	1.34	.76	.99	1.07	1.13	.52	.76	.83	.87
	20	10	40	.88	1.06	1.14	1.19	.70	.89	.96	1.00	.47	.69	.74	.77
	20	35	20	1.55	2.07	2.23	2.42	1.22	1.64	1.88	2.03	.83	1.30	1.46	1.58
	20	35	40	1.26	1.58	1.75	1.89	.99	1.33	1.47	1.59	.67	1.07	1.14	1.23
	20	60	20	2.13	2.81	3.19	3.49	1.68	2.37	2.64	2.94	1.15	1.94	2.09	2.20
	20	60	40	1.63	2.10	2.36	2.58	1.29	1.76	1.94	2.17	.89	1.36	1.54	1.68
MC	20	10	20	.15	.27	.28	.29	.09	.19	.19	.19	.07	.12	.13	.13
	20	10	40	.13	.24	.25	.25	.08	.15	.16	.16	.06	.11	.11	.11
	20	35	20	.25	.49	.54	.58	.16	.32	.35	.38	.11	.23	.25	.27
	20	35	40	.20	.38	.41	.44	.13	.24	.26	.28	.09	.17	.19	.20
	20	60	20	.36	.71	.80	.87	.23	.46	.52	.57	.16	.33	.37	.41
	20	60	40	.26	.51	.57	.63	.17	.33	.37	.41	.12	.24	.27	.29

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
V	H	C	T												
LDV	20	10	60	.40	.44	.48	.50	.33	.34	.37	.39	.27	.26	.29	.31
	20	10	90	.39	.42	.46	.48	.31	.33	.36	.37	.26	.25	.28	.29
	20	35	60	.60	.64	.72	.77	.52	.53	.59	.63	.47	.44	.49	.53
	20	35	90	.54	.58	.64	.69	.47	.48	.53	.57	.43	.40	.45	.48
	20	60	60	.79	.89	.95	1.04	.71	.71	.80	.88	.66	.61	.67	.75
	20	60	90	.69	.73	.82	.90	.63	.63	.71	.77	.59	.55	.62	.68
LDT	20	10	60	.83	.99	1.05	1.10	.66	.83	.89	.93	.44	.64	.69	.71
	20	10	90	.80	.95	1.00	1.04	.63	.80	.85	.88	.41	.61	.65	.69
	20	35	60	1.08	1.31	1.46	1.57	.86	1.12	1.23	1.32	.54	.86	.96	1.02
	20	35	90	.97	1.19	1.29	1.39	.77	.99	1.09	1.16	.52	.74	.84	.90
	20	60	60	1.32	1.67	1.87	2.04	1.05	1.40	1.58	1.72	.72	1.08	1.21	1.32
	20	60	90	1.13	1.41	1.57	1.71	.97	1.19	1.33	1.45	.62	.91	1.02	1.11
MC	20	10	60	.12	.22	.22	.22	.08	.14	.14	.14	.05	.10	.10	.10
	20	10	90	.11	.20	.20	.20	.07	.13	.13	.13	.05	.09	.09	.09
	20	35	60	.16	.29	.32	.34	.10	.19	.20	.21	.07	.13	.14	.15
	20	35	90	.13	.23	.25	.26	.08	.15	.16	.16	.05	.11	.11	.11
	20	60	60	.19	.37	.41	.46	.12	.24	.27	.29	.08	.17	.19	.20
	20	60	90	.14	.27	.30	.32	.09	.17	.19	.20	.06	.12	.13	.14
HDG				1.57	3.07	4.67	5.63	1.52	3.21	3.91	4.78	1.55	2.57	3.21	3.75
HDD				.33	.52	.53	.51	.33	.52	.52	.51	.33	.52	.52	.50

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy-duty diesel.

Table 8. (Continued)

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EMISSION CORRECTION FACTORS FOR REGION: CALIFORNIA

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
**	H	C	T												
LDV	20	10	20	.18	.40	.44	.46	.11	.35	.39	.42	.06	.31	.34	.36
	20	10	40	.17	.38	.41	.43	.13	.32	.35	.37	.06	.29	.32	.33
	20	35	20	.28	.73	.82	.89	.17	.65	.73	.79	.11	.59	.67	.73
	20	35	40	.24	.64	.72	.79	.15	.57	.64	.69	.10	.52	.58	.63
	20	60	20	.38	1.06	1.21	1.32	.24	.95	1.08	1.19	.16	.87	.99	1.09
	20	60	40	.32	.91	1.03	1.12	.20	.81	.92	1.01	.13	.75	.85	.93
LDT	20	10	20	.91	.85	.88	.90	.64	.70	.74	.75	.45	.55	.59	.61
	20	10	40	.77	.80	.83	.84	.60	.66	.69	.70	.43	.52	.55	.57
	20	35	20	1.32	1.47	1.57	1.68	1.04	1.20	1.37	1.42	.77	.97	1.08	1.17
	20	35	40	1.16	1.25	1.37	1.46	.93	1.06	1.16	1.24	.69	.86	.95	1.02
	20	60	20	1.92	2.09	2.25	2.45	1.45	1.70	1.91	2.09	1.09	1.39	1.58	1.77
	20	60	40	1.56	1.71	1.91	2.08	1.25	1.46	1.63	1.78	.94	1.20	1.36	1.48
MC	20	10	20	.26	.29	.31	.32	.17	.18	.20	.20	.12	.13	.13	.14
	20	10	40	.23	.25	.27	.28	.15	.16	.17	.17	.11	.11	.12	.12
	20	35	20	.47	.52	.58	.63	.32	.34	.37	.40	.23	.24	.26	.28
	20	35	40	.36	.40	.44	.48	.24	.26	.28	.30	.17	.18	.20	.21
	20	60	20	.69	.75	.85	.94	.46	.49	.55	.60	.33	.34	.39	.43
	20	60	40	.50	.55	.62	.67	.33	.35	.40	.43	.24	.25	.28	.30

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
*	H	C	T												
LDV	20	10	60	.16	.36	.38	.40	.10	.31	.33	.35	.06	.27	.30	.31
	20	10	80	.15	.35	.37	.39	.09	.30	.32	.34	.05	.26	.29	.30
	20	35	60	.22	.58	.64	.69	.14	.51	.57	.62	.09	.47	.52	.57
	20	35	80	.20	.53	.59	.63	.13	.47	.53	.57	.08	.43	.48	.52
	20	60	60	.28	.79	.90	.98	.18	.72	.81	.89	.12	.66	.75	.82
	20	60	80	.25	.72	.81	.88	.16	.65	.73	.80	.11	.60	.69	.74
LDT	20	10	60	.74	.76	.79	.79	.58	.63	.66	.67	.41	.50	.53	.54
	20	10	80	.72	.74	.76	.76	.56	.61	.63	.64	.40	.48	.51	.52
	20	35	60	1.05	1.13	1.23	1.30	.84	.96	1.05	1.12	.63	.78	.86	.93
	20	35	80	.98	1.04	1.13	1.19	.78	.89	.97	1.02	.58	.73	.80	.85
	20	60	60	1.37	1.50	1.67	1.81	1.11	1.28	1.44	1.56	.84	1.07	1.20	1.31
	20	60	80	1.24	1.35	1.50	1.62	1.00	1.16	1.30	1.41	.77	.97	1.09	1.19
MC	20	10	60	.21	.23	.24	.25	.14	.15	.15	.15	.10	.10	.10	.10
	20	10	80	.19	.21	.22	.22	.13	.13	.14	.14	.09	.09	.09	.09
	20	35	60	.29	.31	.34	.36	.19	.20	.22	.23	.13	.14	.15	.16
	20	35	80	.23	.25	.27	.29	.15	.16	.17	.18	.10	.11	.12	.12
	20	60	60	.36	.40	.44	.48	.24	.25	.27	.31	.17	.18	.20	.21
	20	60	80	.26	.29	.32	.34	.17	.18	.20	.22	.12	.13	.14	.15
HDG				1.19	3.77	4.81	6.04	1.25	3.09	4.00	5.01	1.38	2.45	3.27	4.11
HDD				.03	.60	.52	.51	.03	.59	.52	.50	.03	.59	.52	.50

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy duty diesel.

Table 8. (Continued)

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EMISSION CORRECTION FACTORS FOR REGION: CALIFORNIA

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
M**	H	C	T												
LDV	20	10	20	1.09	1.07	1.11	1.14	.74	.81	.85	.87	.44	.60	.63	.65
	20	10	40	1.02	1.00	1.02	1.04	.69	.74	.79	.80	.41	.56	.59	.61
	20	35	20	1.64	1.71	1.87	2.01	1.10	1.33	1.46	1.57	.46	1.01	1.12	1.21
	20	35	40	1.41	1.45	1.58	1.68	.96	1.14	1.25	1.33	.58	.88	.97	1.04
	20	60	20	2.19	2.35	2.64	2.87	1.47	1.84	2.07	2.24	.88	1.43	1.61	1.76
	20	60	40	1.79	1.91	2.14	2.32	1.22	1.52	1.71	1.84	.74	1.20	1.35	1.47
LDT	20	10	20	1.62	1.53	1.55	1.56	1.41	1.35	1.38	1.39	1.16	1.13	1.17	1.19
	20	10	40	1.51	1.47	1.43	1.42	1.32	1.24	1.28	1.29	1.09	1.06	1.09	1.10
	20	35	20	2.53	2.46	2.67	2.84	2.21	2.20	2.40	2.56	1.85	1.97	2.05	2.19
	20	35	40	2.15	2.08	2.24	2.36	1.92	1.89	2.04	2.16	1.62	1.63	1.77	1.88
	20	60	20	3.43	3.39	3.79	4.12	3.05	3.05	3.42	3.77	2.55	2.61	2.93	3.19
	20	60	40	2.79	2.75	3.05	3.31	2.52	2.51	2.80	3.04	2.14	2.19	2.45	2.66
MC	20	10	20	.66	.83	.95	1.04	.56	.69	.76	.81	.48	.56	.61	.64
	20	10	40	.60	.75	.95	.94	.50	.61	.67	.71	.42	.49	.53	.55
	20	35	20	1.10	1.39	1.58	1.75	.99	1.21	1.36	1.49	.87	1.07	1.14	1.24
	20	35	40	.87	1.10	1.26	1.39	.77	.94	1.05	1.14	.67	.78	.97	.94
	20	60	20	1.54	1.74	2.27	2.46	1.42	1.73	1.97	2.17	1.26	1.48	1.67	1.84
	20	60	40	1.15	1.45	1.66	1.83	1.04	1.26	1.43	1.57	.91	1.07	1.21	1.32

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
M	H	C	T												
LDV	20	10	60	.98	.94	.96	.98	.66	.72	.74	.75	.40	.53	.56	.57
	20	10	80	.94	.91	.92	.93	.64	.69	.71	.72	.38	.51	.53	.55
	20	35	60	1.24	1.27	1.37	1.45	.85	1.01	1.09	1.16	.51	.78	.86	.92
	20	35	80	1.12	1.14	1.22	1.28	.77	.91	.98	1.04	.47	.72	.79	.83
	20	60	60	1.50	1.60	1.74	1.92	1.03	1.30	1.45	1.57	.63	1.04	1.16	1.27
	20	60	80	1.29	1.37	1.52	1.64	.90	1.13	1.24	1.36	.56	.92	1.03	1.12
LDT	20	10	60	1.43	1.34	1.34	1.32	1.25	1.19	1.20	1.20	1.04	1.01	1.03	1.03
	20	10	80	1.37	1.28	1.27	1.25	1.21	1.15	1.15	1.14	1.01	.98	.99	.99
	20	35	60	1.87	1.81	1.93	2.02	1.69	1.66	1.78	1.87	1.44	1.45	1.57	1.65
	20	35	80	1.67	1.61	1.70	1.77	1.53	1.50	1.59	1.67	1.32	1.32	1.42	1.49
	20	60	60	2.32	2.28	2.52	2.72	2.13	2.13	2.36	2.55	1.85	1.89	2.10	2.27
	20	60	80	1.98	1.94	2.14	2.29	1.85	1.85	2.04	2.19	1.64	1.67	1.85	2.00
MC	20	10	60	.55	.69	.77	.86	.45	.55	.60	.64	.38	.45	.47	.49
	20	10	80	.51	.65	.74	.81	.42	.51	.55	.59	.35	.41	.43	.45
	20	35	60	.71	.89	1.02	1.12	.61	.74	.82	.89	.52	.61	.67	.72
	20	35	80	.59	.74	.85	.93	.49	.60	.66	.71	.41	.48	.53	.56
	20	60	60	.87	1.10	1.25	1.38	.76	.93	1.05	1.15	.66	.77	.87	.94
	20	60	80	.67	.84	.96	1.04	.54	.69	.76	.83	.47	.55	.62	.67
HDG				1.44	5.41	5.77	7.04	1.33	5.17	5.90	7.29	1.25	4.89	6.01	7.52
HDD				.03	.63	.57	.58	.03	.61	.54	.54	.03	.60	.53	.52

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy duty diesel.

Table 8. (Continued)

EMISSION CORRECTION FACTORS FOR REGION: HIGH ALTITUDE

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
W**	H	C	T												
LDV	20	10	20	1.04	1.73	2.13	2.44	.85	1.46	1.76	1.98	.65	1.07	1.26	1.40
	20	10	40	.93	1.56	1.93	2.22	.76	1.30	1.58	1.79	.58	.96	1.13	1.26
	20	35	20	1.84	2.94	3.48	3.71	1.53	2.56	2.79	3.33	1.19	1.87	2.17	2.40
	20	35	40	1.48	2.34	2.79	3.14	1.21	2.00	2.35	2.62	.94	1.47	1.71	1.90
	20	60	20	2.65	4.16	4.83	5.18	2.22	3.65	4.27	4.68	1.73	2.67	3.07	3.40
	20	60	40	2.02	3.13	3.65	4.07	1.66	2.62	3.11	3.46	1.10	1.99	2.29	2.54
LDT	20	10	20	1.97	2.20	2.77	3.21	1.71	2.02	2.50	2.87	1.44	1.87	2.24	2.56
	20	10	40	1.79	2.01	2.55	2.97	1.56	1.83	2.29	2.63	1.30	1.68	2.04	2.31
	20	35	20	3.39	3.64	4.35	4.91	2.93	3.39	4.02	4.57	2.48	3.21	3.76	4.20
	20	35	40	2.76	2.98	3.59	4.07	2.39	2.73	3.26	3.68	2.00	2.53	2.99	3.34
	20	60	20	4.81	5.08	5.92	6.61	4.15	4.76	5.53	6.17	3.51	4.55	5.27	5.85
	20	60	40	3.73	3.94	4.62	5.17	3.21	3.63	4.24	4.73	2.64	3.19	3.93	4.37
MC	20	10	20	1.45	1.09	1.37	1.63	.88	.88	1.12	1.32	.58	.70	.90	1.05
	20	10	40	1.28	.98	1.26	1.50	.77	.79	1.01	1.17	.50	.62	.80	.94
	20	35	20	2.47	1.84	2.21	2.62	1.66	1.58	1.89	2.14	1.12	1.30	1.55	1.76
	20	35	40	2.08	1.45	1.77	2.03	1.28	1.21	1.47	1.69	.95	.99	1.20	1.37
	20	60	20	3.90	2.59	3.03	3.40	2.44	2.27	2.65	2.74	1.66	1.99	2.21	2.47
	20	60	40	2.88	1.93	2.27	2.56	1.79	1.65	1.94	2.18	1.20	1.36	1.60	1.79

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
W	H	C	T												
LDV	20	10	60	.97	1.45	1.81	2.08	.70	1.21	1.46	1.65	.54	.89	1.05	1.17
	20	10	80	.82	1.37	1.73	1.99	.66	1.14	1.39	1.58	.51	.85	1.00	1.12
	20	35	60	1.24	1.96	2.35	2.66	1.01	1.65	1.95	2.18	.79	1.23	1.44	1.59
	20	35	80	1.08	1.71	2.06	2.34	.88	1.44	1.71	1.91	.69	1.08	1.27	1.40
	20	60	60	1.61	2.47	2.89	3.23	1.31	2.10	2.44	2.71	1.04	1.57	1.82	2.01
	20	60	80	1.33	2.04	2.40	2.69	1.09	1.73	2.02	2.25	.88	1.32	1.51	1.69
LDT	20	10	60	1.66	1.88	2.41	2.81	1.45	1.71	2.15	2.48	1.21	1.56	1.90	2.16
	20	10	80	1.57	1.79	2.30	2.69	1.38	1.63	2.05	2.37	1.16	1.48	1.87	2.07
	20	35	60	2.31	2.57	3.07	3.50	2.02	2.30	2.77	3.14	1.69	2.11	2.51	2.81
	20	35	80	2.00	2.21	2.71	3.10	1.76	2.02	2.45	2.78	1.48	1.85	2.21	2.48
	20	60	60	2.97	3.16	3.73	4.19	2.59	2.90	3.40	3.80	2.16	2.67	3.11	3.46
	20	60	80	2.43	2.63	3.11	3.51	2.15	2.41	2.84	3.19	1.81	2.22	2.59	2.89
MC	20	10	60	1.15	.90	1.17	1.39	.69	.70	.92	1.09	.45	.55	.73	.86
	20	10	80	1.07	.84	1.10	1.32	.63	.65	.86	1.03	.41	.50	.67	.80
	20	35	60	1.65	1.17	1.45	1.67	1.00	.95	1.17	1.35	.66	.76	.94	1.08
	20	35	80	1.34	.97	1.21	1.41	.80	.74	.94	1.11	.52	.60	.76	.88
	20	60	60	2.15	1.45	1.72	1.95	1.31	1.20	1.43	1.61	.87	.98	1.16	1.31
	20	60	80	1.61	1.10	1.32	1.51	.97	.88	1.05	1.20	.62	.70	.84	.95
HDG				7.36	8.61	8.19	9.48	7.29	8.13	8.29	9.70	7.14	7.41	[illegible]	10.15
HDD				.09	1.01	.37	1.00	.08	.29	.32	.92	.07	.97	.89	.87

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy duty diesel.

Table 8. (Continued)

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EMISSION CORRECTION FACTORS FOR REGION: HIGH ALTITUDE

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
W**	H	C	T												
LDV	20	10	20	.45	.64	.73	.80	.37	.46	.52	.57	.31	.32	.36	.39
	20	10	40	.40	.58	.66	.72	.34	.42	.48	.51	.29	.30	.33	.36
	20	35	20	.84	1.13	1.29	1.42	.71	.83	.95	1.04	.61	.60	.68	.75
	20	35	40	.68	.91	1.04	1.15	.59	.69	.77	.86	.52	.57	.59	.64
	20	60	20	1.22	1.62	1.86	2.05	1.04	1.20	1.38	1.52	.90	.88	1.00	1.10
	20	60	40	.96	1.25	1.43	1.57	.85	.96	1.10	1.21	.76	.74	.84	.92
LDT	20	10	20	1.06	1.46	1.73	1.92	.81	1.17	1.37	1.52	.54	.85	.98	1.08
	20	10	40	.96	1.37	1.55	1.73	.74	1.05	1.21	1.36	.49	.74	.83	.96
	20	35	20	1.81	2.49	2.90	3.21	1.39	1.79	2.30	2.54	.91	1.45	1.67	1.84
	20	35	40	1.46	1.96	2.29	2.54	1.12	1.57	1.82	2.01	.74	1.13	1.31	1.44
	20	60	20	2.57	3.53	4.07	4.50	1.96	2.81	3.23	3.57	1.29	2.05	2.35	2.59
	20	60	40	1.96	2.67	3.03	3.35	1.50	2.09	2.41	2.66	.99	1.51	1.74	1.92
MC	20	10	20	.26	.34	.44	.52	.14	.20	.26	.30	.08	.13	.16	.19
	20	10	40	.23	.30	.39	.46	.17	.14	.23	.27	.07	.11	.14	.17
	20	35	20	.50	.63	.76	.86	.27	.37	.45	.51	.16	.24	.29	.33
	20	35	40	.38	.48	.59	.67	.21	.28	.35	.39	.12	.18	.22	.25
	20	60	20	.75	.92	1.08	1.20	.41	.55	.64	.71	.24	.35	.41	.46
	20	60	40	.54	.67	.78	.88	.29	.39	.46	.52	.17	.25	.30	.33

			YEAR:	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45
W	H	C	T												
LDV	20	10	60	.38	.54	.62	.67	.32	.40	.45	.48	.27	.28	.31	.34
	20	10	80	.36	.51	.57	.64	.30	.38	.43	.46	.26	.27	.30	.32
	20	35	60	.59	.78	.89	.98	.52	.60	.68	.75	.47	.46	.52	.57
	20	35	80	.52	.70	.80	.88	.47	.54	.62	.68	.43	.42	.48	.52
	20	60	60	.80	1.02	1.17	1.29	.72	.81	.92	1.01	.66	.64	.73	.80
	20	60	80	.69	.88	1.01	1.11	.64	.71	.81	.89	.60	.57	.65	.72
LDT	20	10	60	.89	1.21	1.45	1.62	.69	.97	1.15	1.27	.46	.70	.82	.90
	20	10	80	.85	1.14	1.39	1.55	.66	.93	1.10	1.22	.44	.67	.78	.86
	20	35	60	1.24	1.65	1.93	2.14	.95	1.32	1.53	1.70	.63	.95	1.10	1.21
	20	35	80	1.10	1.45	1.71	1.90	.85	1.17	1.34	1.51	.57	.85	.98	1.07
	20	60	60	1.58	2.08	2.40	2.66	1.22	1.66	1.92	2.12	.80	1.20	1.38	1.52
	20	60	80	1.34	1.75	2.02	2.24	1.04	1.41	1.62	1.80	.69	1.02	1.17	1.29
MC	20	10	60	.20	.27	.36	.42	.11	.16	.21	.25	.06	.10	.13	.16
	20	10	80	.18	.25	.33	.39	.10	.14	.19	.23	.05	.09	.12	.14
	20	35	60	.30	.37	.46	.53	.16	.22	.27	.31	.09	.14	.17	.20
	20	35	80	.23	.30	.37	.43	.12	.17	.22	.25	.07	.11	.14	.16
	20	60	60	.39	.48	.57	.64	.21	.29	.34	.38	.17	.19	.21	.24
	20	60	80	.29	.34	.41	.47	.15	.20	.24	.28	.08	.13	.15	.17
HDG				1.83	5.57	6.51	7.93	1.67	4.27	5.11	6.25	1.62	3.02	3.79	4.64
HDD				.76	.86	.77	.74	.04	.74	.66	.61	.03	.65	.57	.55

**LDV-light duty vehicles, LDT-light duty trucks, MC-motorcycles, HDG-heavy duty gas trucks, HDD-heavy duty diesel.

Table 8. (Continued)

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Carbon Monoxide Hot Spot Guidelines
Volume III: Workbook

by

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ABSTRACT

This report presents a summary of the guidelines for the identification and evaluation of localized violations of carbon monoxide air quality standards in the vicinity of streets and highways. The guidelines are provided to facilitate the rapid and efficient review of CO conditions along existing roadway networks, without the need for extensive air quality monitoring, and are based upon the use of limited traffic data. Two stages of review are provided for. Preliminary screening, performed with simple nomographs included herein, simply identifies those locations with the potential to violate CO standards; no quantitative estimate of CO concentrations results from preliminary screening. Verification screening, using procedures and forms provided herein, allows for consideration of additional site-specific conditions and provides quantitative estimates of maximum CO concentrations. Both screening procedures are performed manually and are based upon the EPA Indirect Source Review Guidelines. Data collection procedures, computation techniques, and forms are recommended, and examples are provided. A more comprehensive explanation of the guidelines in terms of their development, technical basis, capabilities and limitations is provided in Volume I.

PREFACE

This document is the third in a series comprising the *Carbon Monoxide Hot Spot Guidelines*. The purpose of this series is to provide state and local agencies with a relatively simple yet accurate procedure for assessing carbon monoxide hot spot potential on urban street networks. Included in the Hot Spot Guideline series are:

Volume I: Techniques[1]
Volume II: Rationale[2]
Volume III: Summary Workbook[3]
Volume IV: Documentation of Computer Programs to Generate Volume I Curves and Tables[4]
Volume V: Intersection-Midblock Model User's Manual[5]
Volume VI: Modified ISMAP User's Manual[6]
Volume VII: Example Applications at Waltham/Providence/Washington, D.C.[7]

Hot spots are defined as locations where ambient carbon monoxide concentrations exceed the national ambient air quality standards (NAAQS). For both the 1-hour and 8-hour averaging times the assumption is made throughout these guidelines that a CO hot spot is primarily affected by local vehicle emissions, rather than areawide emissions. Studies have shown that for the 1-hour CO concentration, local sources are the dominant factor. Accordingly, representative urban worst-case meteorological, traffic, and background concentration conditions are selected as those corresponding to the period of maximum local emissions — usually the period of peak traffic. For 8-hour concentrations evidence indicates that neither the local nor the areawide contributions can be assumed to be dominant in every case. However, for the purpose of analysis discussed in these guidelines, local source domination of CO hot spots is assumed for 8-hour averages. This allows some consistency between assumptions in relating the 1-hour and 8-hour CO estimates.

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SECTION I

INTRODUCTION

This volume provides a summary of the analytical procedures described in the Carbon Monoxide Hot Spot Guidelines, Volume I[1] document. The purpose of this volume is to provide only the material that is required to perform the hot spot analysis in a convenient format. Omitted is most of the explanatory discussion dealing with topics such as the fundamentals of air quality analysis, and the development of the procedures.

The screening procedures are discussed in Section II. Included are (1) an overview of the procedure, (2) step-by-step instructions for conducting the screening, (3) worksheets and nomographs, and (4) an example showing the screening procedure applied in the analysis of hot spot potential at a signalized intersection.

The verification procedure is described in Section III. Included are: (1) an overview of the procedure, (2) description of the data requirements, (3) worksheets and instructions for conducting the analysis, and (4) an example application of the procedure.

Again, it is stressed that this document provide only the minimum instructions and other material necessary to conduct a hot spot analysis. It would be very helpful for the user to become familiar with Volume I, which provides detailed discussions of the entire scope of hot spot analysis.

SECTION II

HOT SPOT SCREENING

A. OVERVIEW OF THE SCREENING PROCEDURE

A description of the screening procedure must include discussion of three critical elements, viz: (1) the data required, (2) the nomographs that relate the roadway and traffic operating characteristics to air quality, and (3) a set of standard worksheets on which the input data and the results of the analysis are recorded. Each of these elements is described below.

1. Data Requirements

The entire screening procedure may be possible to complete for many communities with only a minimal field data collection effort. Data required include areawide traffic volume data and a street inventory of sufficient detail to indicate the lane composition (use and number of lanes), traffic control utilized (mainly, the locations of signalized intersections are of primary importance), and whether various streets operate one-way or two-way, and whether or not congested conditions normally prevail. Also, additional backup data are required to estimate the lane capacity of arterial streets and expressways, as will be mentioned later. The data required for hot spot screening for signalized intersections, nonsignalized intersections, and arterials and expressways are summarized in Table 1.

a. Traffic Volume Data - Traffic volume data should be summarized in the form of a traffic flow map indicating the highest monthly average daily traffic (ADT) volumes for the winter season, reflecting the 1982-1983 period. Volumes can be adjusted by the application of annual growth factors. Volume

Table 1. SUMMARY OF DATA REQUIREMENTS FOR HOT SPOT SCREENING

Signalized Intersections

- Location of signalized intersections.
- Street inventory to determine lane use and number and directional operation of intersection approaches.
- Volume data (ADT) for all intersection approaches.

Nonsignalized Intersections

- Location of signed control intersections.
- Street inventory to determine lane use and number and directional operation of intersection approaches.
- Volume data (ADT) for all intersection approaches.
- Lane capacity on major through street

Uninterrupted Flow

- Location and number of lanes of expressway and arterials of uninterrupted flow.
- Volume data (ADT) for the facility
- Roadway lane capacity

data need not be developed for every street on the network; of primary interest should be: (1) those streets and highways on the Federal Aid System, (2) those not on the Federal Aid System but that are controlled by traffic signals; and (3) those not on the Federal Aid System but that are considered by local officials to be "important" or high volume facilities.

Traffic volume is perhaps the most readily available data element concerning a highway network. The intent here is that existing data be used wherever possible, implying that existing volume data should be available in most instances to develop a suitable traffic flow map. In many communities where traffic studies or transportation plans have been developed, flow maps may already be available requiring only minimal updating. Development of flow maps, however, should be carefully guided by cognizant highway and transportation planning officials.

b. Highway Inventory Data - Highway inventories are normally available from state transportation planning or highway departments. These inventories should be made available for each community where hot spots are being investigated. The required data that can be obtained from these inventories include descriptions of operational characteristics of the roadways (e.g., one-way or two-way operation); information regarding the number of lanes, use of medians, functional classification, etc., and occasionally, volume data. Also, data must be obtained regarding intersectional traffic control, particularly the locations where traffic signals are utilized. It is helpful if the locations of all signalized intersections are plotted on a base map.

c. General Backup Data - Other data elements are required that may not be available from previous studies or from existing inventories. Included is information required to estimate the lane capacity of streets on the network, mainly, estimates of truck factors, knowledge of conditions such as restricted lateral clearances, severe terrain features, etc. This information can be obtained through local planning or engineering personnel and by field reconnaissance. For a comprehensive discussion of roadway lane capacity, the reader is referred to the Highway Research Board's Special Report No. 87, the 1965 Highway Capacity Manual. A methodology for calculating capacities based on this document is presented in Section II.D of these guidelines.

2. Definitions

Several terms used in the screening procedure are defined below.

a. *Complex Intersection* - This term refers to a signalized intersection that, because of volume demand, turning movements, geometry, number of approaches, etc., requires three or more signal phases. Also, an intersection characterized by very heavy pedestrian activity as well as high volumes on all approaches may be considered a complex intersection. Complex intersections cannot be appropriately analyzed using the screening procedure.

b. *Special Case* - A special case refers to either a signalized or nonsignalized intersection where conditions are such that, again, the screening procedure is not appropriate for evaluating hot spot potential. Examples of special cases include locations (1) where signals are used only for certain events such as during peak-hour only, or during work-shift changes if the location is in the vicinity of a major industrial or office complex; (2) where signals are manually operated or preempted in favor of traffic direction by police personnel; (3) where signals are utilized for pedestrian crossing protection only; and (4) where police control is utilized at nonsignalized intersections.

c. *Congested/Noncongested Areas* - These terms are utilized in the screening procedure to indicate whether or not significant interference to traffic departing from an intersection can be expected. For congested areas, downstream cruise speeds will be fairly low (less than about 20 miles per hour) with some interruptions occurring. In noncongested areas, however, few if any interruptions to departing traffic will occur, and downstream cruise speeds will be somewhat higher (at least 25 miles per hour).

3. Nomographs for Hot Spot Screening

The nomographs for screening provide the basic tool for relating various traffic and roadway characteristics to hot spot potential. In particular, these nomographs relate a roadway's average daily volume demand and capacity characteristics to potential for exceeding the National Ambient Air Quality Standard for 8-hour average concentrations of carbon monoxide (10.0 mg/m^3 (9.0 ppm)). Hot spot potential is indicated when the respective ADT's for any particular street under analysis and cross street are plotted on the nomograph and the point plotted falls on or above the curve. The use of the nomographs is explained in detail in the following paragraphs. Separate sets of nomographs are presented for three distinct types of street locations including signalized intersections, nonsignalized intersections, and for conditions where uninterrupted flow prevails. Each of these is discussed below.

a. Signalized Intersections - Ten separate nomographs are presented. Each of the nomographs was developed for screening intersection approaches of a particular configuration. Included are nomographs developed for screening:

- 2-lane, 2-way (congested area)
- 2-lane, 2-way (noncongested area)
- 3-lane, 2-way (congested area)
- 3-lane, 2-way (noncongested area)
- 4-lane, 2-way (congested area)
- 4-lane, 2-way (noncongested area)
- 3-lane, 1-way (congested area)
- 3-lane, 1-way (noncongested area)
- 2-lane, 1-way (congested area)
- 2-lane, 1-way (noncongested area)

A series of five curves appears on each nomograph. Each of these curves represents a particular configuration of the cross street (with respect to the approach being screened). Curves representing the following cross street configurations are plotted on each nomograph:

- 2-lane, 1-way
- 2-lane, 2-way
- 3-lane, 1-way
- 3-lane, 2-way
- 4-lane, 2-way

Each of the curves is a plot of the ADT on the intersection approach under analysis (abscissa) versus the ADT on the cross street (ordinate).

Each point on any of the curves, then, represents that combination of traffic volumes (on the street under analysis and the cross street) which, under certain assumed conditions, would result in ambient carbon monoxide concentrations at or very close to the 10.0 mg/m^3 permitted by the National Ambient Air Quality Standard for 8-hour average concentrations. These assumed conditions include a maximum distribution of the available green time between the street under analysis and the cross street,* which accounts for the finite limits of the plotted curves on the nomographs. Also assumed is that there is a background concentration present, which comprises 2.9 mg/m^3 of the implied 10.0 mg/m^3 concentration. *If the respective ADT's for any particular configuration of street (under analysis) and cross street are plotted on the nomograph and the point plotted falls on or above the (cross street) curve, the implication is that resulting carbon monoxide concentrations are potentially in the vicinity of 10.0 mg/m^3 or more, indicating that the approach has hot spot potential.* Plotting the ADT's (for winter 1982-1983) in this manner and noting where the plot lies with respect to the cross street curve, is essentially the entire procedure involved for using the nomographs. The appropriate nomograph is selected based on the configuration of the approach being analyzed while selection of the appropriate curve on the nomograph is based on the cross street configuration.

---

*The G/Cy allocated to the street under analysis ranges from 0.20 to 0.80 representing the top left and bottom right extremities of the nomograph curves, respectively. Recall that G/Cy is directly related to ADT and that each approach must be allotted a minimum G/Cy.

b. Uninterrupted Flow - Two types of locations are considered where conditions of uninterrupted flow prevail - these include expressways (controlled access) and arterial streets. One nomograph is presented for each of these two facility-types.

On the nomograph for expressways, three separate curves are plotted representing 4-lane, 6-lane, and 8-lane expressways. These curves are plotted as lane capacity (abscissa) versus ADT (ordinate). Each point on the curve represents that combination of lane capacity and 24-hour volume that, under certain assumed conditions, would result in nearby ambient carbon monoxide concentrations of approximately 10.0 mg/m^3. The implication, again, is that for a particular roadway configuration with a certain lane capacity, *an ADT equal to or in excess of the "critical" ADT (shown by the curve on the nomograph) indicates that the location may be a potential hot spot.*

A similar nomograph is presented for arterial streets showing the critical ADT for various lane configurations. *Again, if the actual ADT (estimated for winter 1982 to 1983) exceeds the "critical" ADT, hot spot potential is indicated.*

The procedure, then, for using either of the nomographs is to plot the estimated lane capacity versus its ADT and observe where this plot lies with respect to the curve corresponding to the facility's configuration - if the plot falls on or above the curve, hot spot potential is indicated.

c. Nonsignalized Intersections - Ten separate nomographs have been developed for the screening of nonsignalized intersections. These nomographs are utilized to screen intersection approaches controlled by STOP-signs only; the through street approaches of a STOP-sign controlled intersection are screened utilizing the nomographs presented for uninterrupted flow.

One curve is plotted on each nomograph, which has ADT for the controlled street and the through street plotted on the x and y axis, respectively. Each nomograph contains a curve representing the combination of ADT's on the street under analysis and the through-street that would result in ambient carbon monoxide concentrations of approximately 10.0 mg/m^3 (assuming certain other conditions prevail as described previously). Therefore, in order to use these nomographs, two elements of data other than the configuration of each street approach must be determined, including (1) the ADT (winter 1982 to 1983) on the street under analysis, and (2) the ADT (winter 1982 to 1983) on the major through street. *If, then, the ADT's are plotted and the point lies on or above the curve, hot spot potential is indicated.*

Selection of the nomograph is based on the configuration of both the STOP-sign controlled street being analyzed and the major through street. Nomographs were developed for the screening of the following STOP-sign controlled street configurations:

- 2-lane, 2-way minor; 2-lane major (congested area)
- 2-lane, 2-way minor; 2-lane major (noncongested area)
- 2-lane, 2-way minor; 4-lane major (congested area)
- 2-lane, 2-way minor; 4-lane major (noncongested area)
- 4-lane, 2-way minor; 4-lane major (congested area)
- 4-lane, 2-way minor; 4-lane major (noncongested area)
- 2-lane, 1-way minor; 2-lane major (congested)
- 2-lane, 1-way minor; 2-lane major (noncongested)
- 2-lane, 1-way minor; 4-lane major (congested)
- 2-lane, 1-way minor; 4-lane major (noncongested)

4. Hot Spot Screening Worksheets

Presented in the following pages are standard worksheets to be used for performing and reporting the screening of a street network. Included are:

Hot Spot Screening Summary Sheet	-	Worksheet 1
Screening Worksheet - Signalized Intersections	-	Worksheet 2
Screening Worksheet - Nonsignalized Intersections	-	Worksheet 3
Screening Worksheet - Uninterrupted Flow	-	Worksheet 4

a. Screening Summary Sheet (Worksheet 1) - This form, as its name implies, is intended to be used for summarizing the hot spot screening effort for a community. The information to be entered on the sheet includes:

1. A description of each location analyzed - Broadway at Park Street, or Vasser Street between Parson's Road and Kennelworth Drive, for example.
2. The type of location analyzed - either signalized intersection, nonsignalized intersection, freely flowing arterial section, or expressway.
3. Whether or not hot spot potential is indicated by the analysis.

The locations listed are then numbered sequentially.

b. Screening Worksheet - Signalized Intersections (worksheet 2) - This worksheet provides space for the analysis of two separate intersections. To complete this form enter the intersecting street's names in Part I, and indicate whether or not the intersection is located in a congested area in Part II. (A congested area implies cruise speeds of less than 20 mph). In Part III, it is indicated whether or not the location should be considered a complex intersection (unusual geometery) or a special case. For locations that are not considered complex intersections or special cases, the actual screening is performed in Part IV.

In Part IV each approach to the intersection is analyzed separately. Under the main column heading "Approach Under Analysis," the approach designation (name and orientation such as Amity Road, south approach), the adjusted average daily traffic volumes, and the roadway configuration (for example, 4-lane, 2-way) are entered.

Under the other main column heading of "Cross-Street Data," the appropriate data elements for the cross street approach having the highest traffic volume are recorded. Then, utilizing the appropriate nomograph and curve, a determination of hot spot potential is made and recorded. If the configuration of the other approach of the cross street is different from the approach previously used in the analysis, the procedure is repeated using the data for the second cross-street approach and the appropriate nomograph and curve. Note that columns f and j provide space to record the figure number and curve designation for the nomograph used to perform the screening.

c. Screening Worksheet - Nonsignalized Intersections (Worksheet 3) - This worksheet allows for the analysis of four nonsignalized intersections. In the first major column, the through street is analyzed in the same fashion as for uninterrupted flow conditions. Each approach of the controlled cross street is then analyzed in the two columns under the heading of "Cross-Street Data."

d. Screening Worksheet - Uninterrupted Flow (Worksheet 4) - Up to 30 locations where conditions of uninterrupted flow prevail can be analyzed on each of these worksheets. The data required include the facility name; a description of its location; its volume, configuration, and capacity; and finally, whether or not hot spot potential is indicated.

B. DETAILED INSTRUCTIONS FOR HOT SPOT SCREENING

The following presents detailed instructions for performing hot spot screening based on utilizing the data, nomographs, worksheets, and general procedure discussed in the previous portion of this section. Included are step-by-step instructions for the three subtasks (analysis of signalized intersections, uninterrupted flow, and nonsignalized intersections) involved in the screening process.

1. Screening Signalized Intersections

a. Step 1 - Prepare a townwide traffic flow map depicting the highest monthly projected ADT's on the street network for the winter months (November through March) of 1982-1983. This should be presented on a suitable base map (or maps) at a scale of between 1 inch = 1,000 feet and 1 inch = 3,000 feet; insets at a larger scale should be used, as appropriate, for congested areas. Volumes should be included for all principal streets including, as a minimum, all streets and highways on the Federal Aid System and on all street sections controlled by traffic signals.

b. Step 2 - Determine the locations where traffic signals are utilized to control traffic.

c. Step 3 - Determine the configuration (i.e., the number of approach and departure lanes) of each approach for all signalized intersections. Also, a determination should be made as to whether each intersection is located in a congested or noncongested area, and whether any of the locations should be classified as complex intersections or special cases (unusual geometry or unusual signal control such as by a police officer).

d. Step 4 - Enter appropriate data for each signalized intersection on the Screening Worksheet - Signalized Intersections, as follows:

1. Part I:
    a. Enter the location (e.g., Main Street at Naussam Road).
2. Part II:
    a. Record whether or not the location is generally within a congested area.

3. Part III:

   a. Record whether or not the location should be considered a complex intersection or special case. If it is either a complex intersection or a special case, enter the location on the Hot Spot Screening Summary Sheet and proceed to the next intersection.

   b. If the location is neither complex nor a special case, proceed to Part IV.

4. Part IV: Each approach of the intersection is analyzed as follows:

   a. Enter the approach designation (e.g., Main Street, south approach) in column a. It is important to identify the particular approach being considered (e.g., Main Street, south approach).

   b. Enter the adjusted ADT (winter 1982-1983) in column b.

   c. Enter the configuration (e.g., 2-lane, 1-way) of the approach in column c.

   d. Enter the name and orientation (e.g., Main Street, east approach) of each cross street approach on the line above columns d through k.

   e. For the first approach of the cross street:

      1. Enter the adjusted ADT (winter 1982-1983) in column d.

      2. Enter its configuration (e.g., 2-lane, 1-way) in column e.

      3. Enter the figure number and curve to be used for screening in column f (see Section II.A.3 for instructions on the selection of figures and curves).

      4. Using the figure and curve noted in column f, determine whether or not hot spot potential exists; record this determination in column g.

   f. For the other approach of the cross street:

      1. Enter the adjusted ADT (winter 1982-1983) in column b.

      2. Enter its configuration (e.g., 2-lane, 2-way) in column i.

3. Enter the figure number and curve to be used for screening in column j (see Section II.A.3 for instructions on the selection of figures and curves).

4. Using the figure and curve noted in column j, determine whether or not hot spot potential exists; record this determination in column k.

g. Repeat the previous steps in Part IV for each approach.

5. After all approaches have been analyzed, enter the location on the Hot Spot Screening Summary Sheet (Worksheet No. 1); include the following data:

   a. Location (street names).

   b. Type (in this case, signalized intersection)

   c. Whether or not a hot spot is indicated - *a hot spot is indicated if* *any* *entry in columns g or k is affirmative.*

e. Step 5 - Repeat Step 4 for all signalized intersections on the street network.

2. Screening Locations Where Conditions of Uninterrupted Flow Prevail

a. Step 1 - Identify sections of expressway (controlled access) where the following conditions prevail:

Highway configuration	ADT
4-lane highway	≥ 40,000
6-lane highway	> 50,000
8-lane highway	> 65,000

These ADT's are slightly below those that would generally have hot spot potential.

b. Step 2 - For each section identified in Step 1 as meeting the above criteria, enter the highway name or route number in column (a) of the Screening Worksheet - Uninterrupted Flow (Worksheet No. 4). Also on this worksheet, enter the following data for each location:

1. Description of the location (e.g., north of the Brook's Highway Interchange) in column b.

2. The adjusted ADT (winter 1982 to 1983) in column c.

3. Highway configuration (e.g., 4-lane expressway) in column d.

4. Estimated lane capacity in column e (see page 46).

5. Using the appropriate curve in the nomograph for expressways, determine whether or not the facility is a potential hot spot (for instructions on selecting the appropriate curve and use of the figure, see Section II.A.3); record this determination in column f.

c. Step 3 - Upon completion of Step 2, record the locations on the Hot Spot Screening Summary Sheet; include:

1. Facility name and location (from columns a and b of the worksheet.

2. Type of facility (in this case, expressway-uninterrupted flow).

3. Whether or not hot spot potential is indicated (from column f of the work sheet.

d. Step 4 - Identify arterial street sections on the highway network that meet the following criteria:

1. Volumes:

Highway configuration	ADT
2-lane arterial	≥ 15,000
4-lane arterial	≥ 25,000
6-lane arterial	≥ 35,000

2. Proximity to Signalized Intersections: *The section should be at least 1 mile from a signalized intersection.*

e. Step 5 - For each arterial section identified in Step 4 as meeting the above criteria, enter the street name (or other identifier) in column a of the Screening Worksheet - Uninterrupted Flow (see Section II.A.4). Also on this worksheet, enter the following data for each location:

1. Description of the location (e.g., between Marginal Way and Ober Road) in column b.
2. The adjusted ADT (winter 1982 to 1983) in column c.
3. Street configuration (e.g., 4-lane arterial) in column d.
4. Estimated lane capacity in column e (see page 46).
5. Using the appropriate curve in the nomograph for arterials, determine whether or not the facility is a potential hot spot (for instructions on selecting the appropriate curve and use of the figure, see Section II.A.3); record this determination in column f.

f. Step 6 - Upon completion of Step 5, record the locations on the Hot Spot Screening Summary Sheet; include:

1. Facility name and location (from columns a and b of the worksheet).
2. Type of facility (in this case, arterial-uninterrupted flow).
3. Whether or not hot spot potential is indicated (from column f of the worksheet.

3. Screening Nonsignalized Intersections

a. Step 1 - Identify all nonsignalized intersections where either the major street or controlled street volumes exceed the critical ADT's shown below (for various street configurations):

Street configurations		Critical ADT's	
Major street	Controlled street[a]	Major street	Controlled street[a]
2-lanes	2-lanes	10,000	2,500
4-lanes	2-lanes	20,000	2,500
4-lanes	4-lanes	20,000	8,000

[a] Under control of STOP sign.

b. Step 2 - For each intersection identified in Step 1 as meeting the above volume criteria, enter the location in Part I of the Screening Worksheet - Nonsignalized Intersections.

c. Step 3 - For Part II of the worksheet enter the following:

1. For the major through street enter:
    a. Adjusted ADT (winter 1982 to 1983) in column a.
    b. Configuration (e.g., 2-lane arterial) in column b.
    c. Using the appropriate curve in the nomograph for arterial streets, determine whether or not hot spot potential exists on the through street; record this determination in column c.
2. For the first controlled street approach enter:
    a. Street name and its orientation (e.g., Trask Lane, east approach).
    b. Adjusted ADT (winter 1982 to 1983) in column d.
    c. Configuration (e.g., 2-lane, 2-way) in column e.
    d. The figure number to be used for screening in column f.
    e. Using the figure designated in column f, determine whether or not hot spot potential exists; record this determination in column g.
3. For the second controlled street approach enter:
    a. Street name and its orientation (e.g., Trask Lane, west approach).
    b. Adjusted ADT (winter 1982 to 1983) in column h.
    c. Configuration (e.g., 2-lane, 1-way) in column i.
    d. The figure number to be used for screening in column j.
    e. Using the figure and curve designated in column j, determine whether or not hot spot potential exists; record this determination in column k.

d. Step 4 - Upon completion of Step 3, record the locations on the Hot Spot Screening Summary Sheet; include:

1. Location (street names).
2. Type (in this case, nonsignalized intersection).
3. Whether or not a hot spot is indicated - *a hot spot is indicated if any entry in columns c, g, or k is affirmative.*

4. Other Locations

Other locations may be identified during the initial screening that should be analyzed for possible hot spot potential. These locations may not be obvious solely from analysis of traffic data; however, interviews with local planning or engineering personnel may result in the identification of such locations. These special cases may include access roads to major industrial facilities or office complexes, shopping centers, or public parking areas. Should locations such as this be identified, they should be entered on the Hot Spot Screening Summary Sheet.

5. Screening Locations Map

The final step in the hot spot screening process is to assign an identification number to each location listed on the Hot Spot Screening Summary Sheet, and then to plot the locations, with their respective identification numbers, on a base map. In preparing this map, separate symbols should be utilized to distinguish signalized intersections, nonsignalized intersections, and locations where uninterrupted flow prevails.

C. WORKSHEETS AND NOMOGRAPHS

The following pages bring together most of the information that is needed to perform hot spot screening, assuming the user has become familiar with the instructions described above. The worksheets may be reproduced for use in the analysis, or similar worksheets can be developed by the user. Again, since the purpose of this document is to provide only the portions of the Guidelines that are required to conduct an analysis, the user may wish to consult the Hot Spot Guidelines, Volume I document to develop a more thorough understanding of the procedure, its applications and its limitations. Presented here, then, are Worksheets 1 through 4, followed by the nomographs (designated as Figures 1 through 22). Immediately following these pages is a discussion on determining roadway capacity, which, in turn, is followed by an example problem illustrating the use of the worksheets and nomographs.

WORKSHEET NO. 1

Hot Spot Screening Summary Sheet page ___ of ___

City/Town: ____________________ **State:** ____________________

Analysis By: ____________________ (name) ________________ (title) **Date:** ________

Approved By: ____________________ (name) ________________ (title) **Date:** ________

Location	**Type**	**Hot Spot Indicated or Detailed Analysis Required**	
		Yes	**No**

WORKSHEET NO. 2

Screening Worksheet - Signalized Intersections

page ___ of ___

City/Town: ______________________ State: ______________________

Analysis By: ______________________ ______________________ Date: __________
(name) (title)

Approved By: ______________________ ______________________ Date: __________
(name) (title)

Part I Location: ____

Part II Congested Area? _____ Yes; _____ No

Part III Complex Intersection or Special Case? _____ Yes; _____ No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each approach separately on the form below.

Approach under analysis			Cross-street data							
			Street: ______ Approach: ______				Street: ______ Approach: ______			
a Designation	b Adjusted ADT	c Configuration	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot spot indicated?
╳	╳	╳	Street: ______ Approach: ______				Street: ______ Approach: ______			

Part I Location: ____

Part II Congested Area? _____ Yes; _____ No

Part III Complex Intersection or Special Case? _____ Yes; _____ No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each approach separately on the form below.

Approach under analysis			Cross-street data							
			Street: ______ Approach: ______				Street: ______ Approach: ______			
a Designation	b Adjusted ADT	c Configuration	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot spot indicated?
╳	╳	╳	Street: ______ Approach: ______				Street: ______ Approach: ______			

WORKSHEET NO. 3

Screening Worksheet - Nonsignalized Intersections

page ___ of ___

City/Town: ______________________ State: ______________________

Analysis By: ______________________ ______________________ Date: __________
(name) (title)

Approved By: ______________________ ______________________ Date: __________
(name) (title)

Part I Location: ______________________

Part II Analyze each cross street approach on the form below:

Through street data			Minor cross street data							
			Street: ________ Approach: ______				Street: ________ Approach: ______			
a Adjusted ADT	b Configuration	c Hot Spot indicated?	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot Spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot Spot indicated?

Part I Location: ______________________

Part II Analyze each cross street approach on the form below:

Through street data			Minor cross street data							
			Street: ________ Approach: ______				Street: ________ Approach: ______			
a Adjusted ADT	b Configuration	c Hot Spot indicated?	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot Spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot Spot indicated?

Part I Location: ______________________

Part II Analyze each cross street approach on the form below:

Through street data			Minor cross street data							
			Street: ________ Approach: ______				Street: ________ Approach: ______			
a Adjusted ADT	b Configuration	c Hot Spot indicated?	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot Spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot Spot indicated?

Part I Location: ______________________

Part II Analyze each cross street approach on the form below:

Through street data			Minor cross street data							
			Street: ________ Approach: ______				Street: ________ Approach: ______			
a Adjusted ADT	b Configuration	c Hot Spot indicated?	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot Spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot Spot indicated?

WORKSHEET NO. 4

Screening Worksheet - Uninterrupted Flow

City/Town: ____________________ **State:** __________ page ___of ___ .

Analysis By: ____________________ (name) ____________________ (title) **Date:** ________

Approved By: ____________________ (name) ____________________ (title) **Date:** ________

a Facility	b Location	c Adjusted ADT	d Configuration	e Est. lane capacity	f Hot Spot indicated?

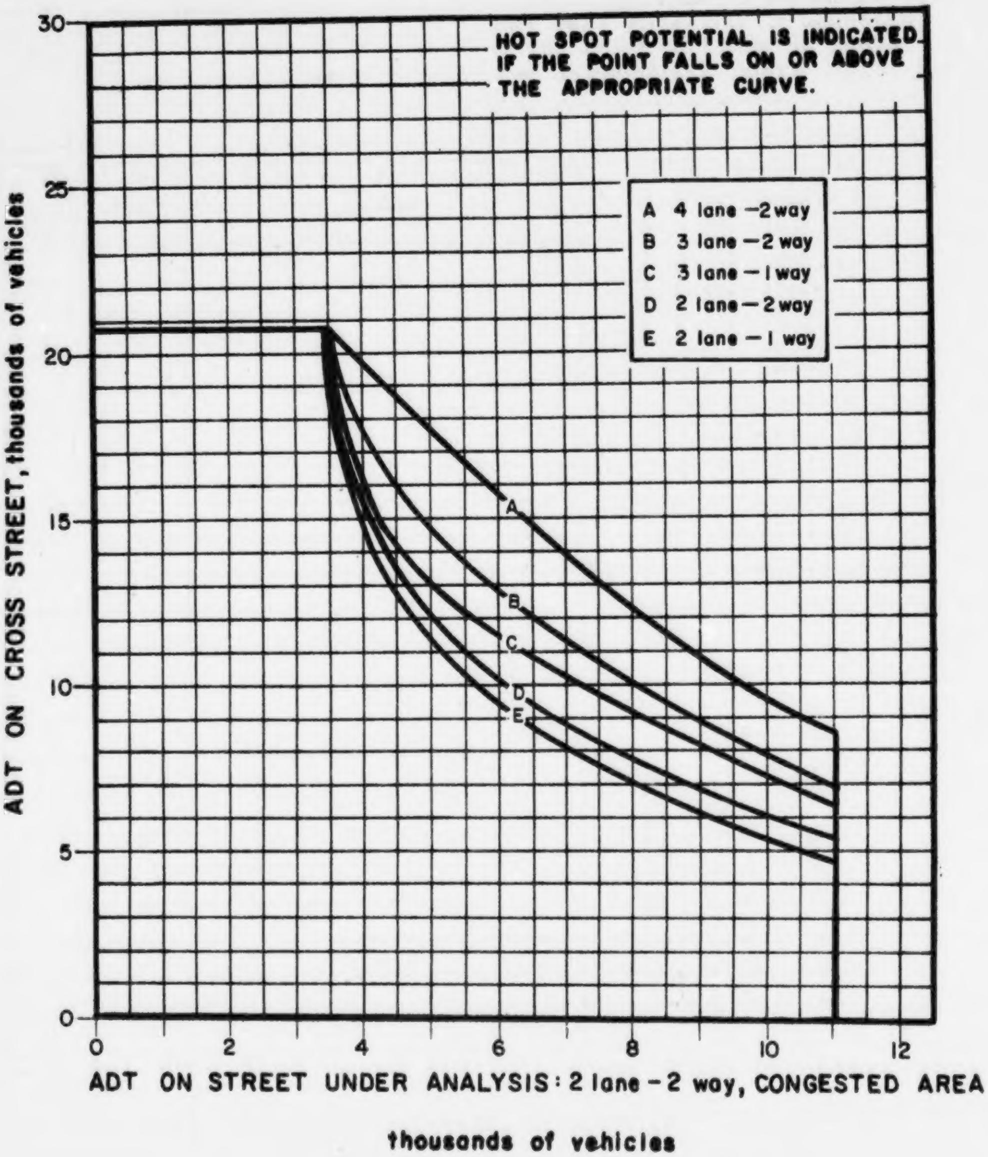

Figure 1. Analysis at signalized intersections of a 2-lane, 2-way street and various cross street configurations in a congested area

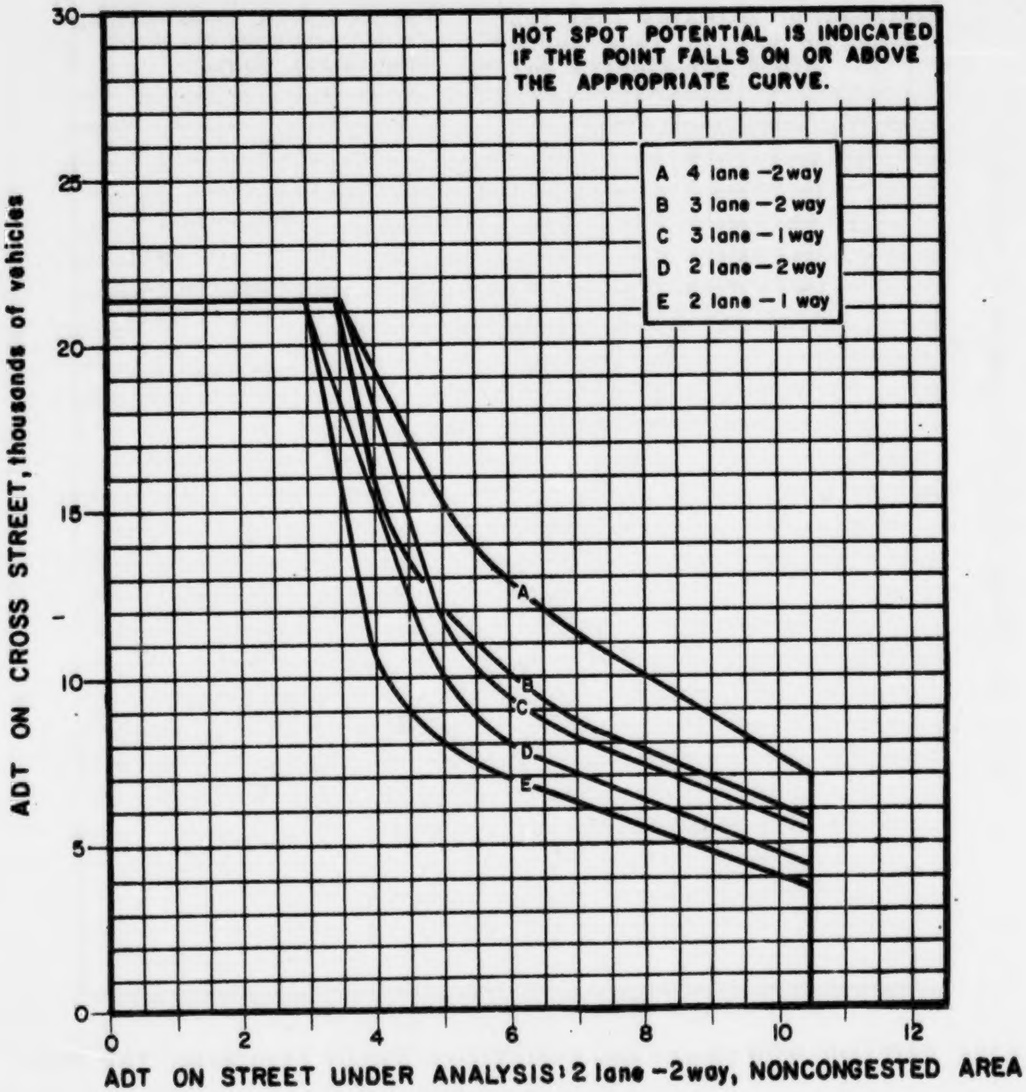

Figure 2. Analysis at signalized intersections of a 2-lane, 2-way street and various cross street configurations in a noncongested area

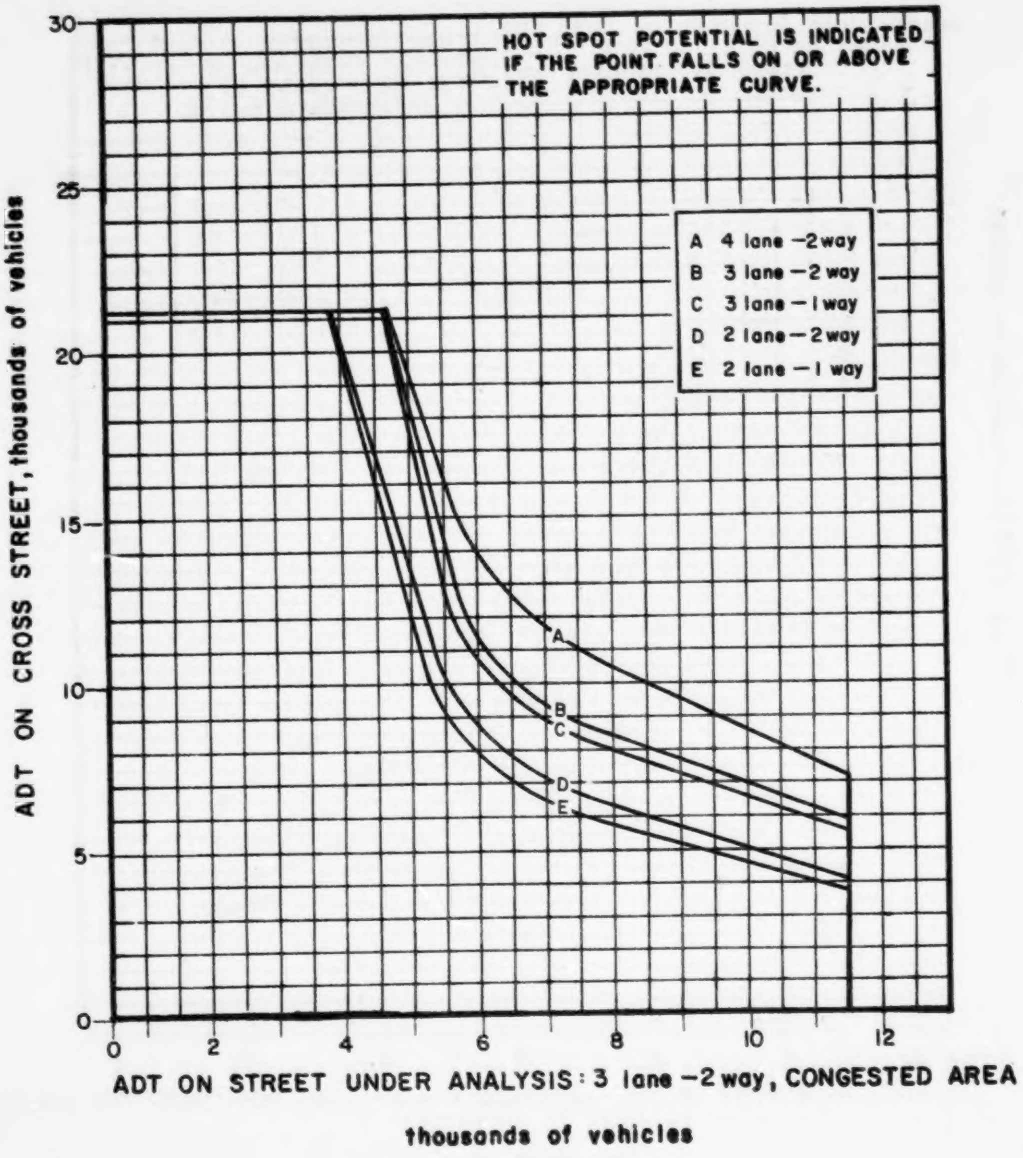

Figure 3. Analysis at signalized intersections of a 3-lane, 2-way street and various cross street configurations in a congested area

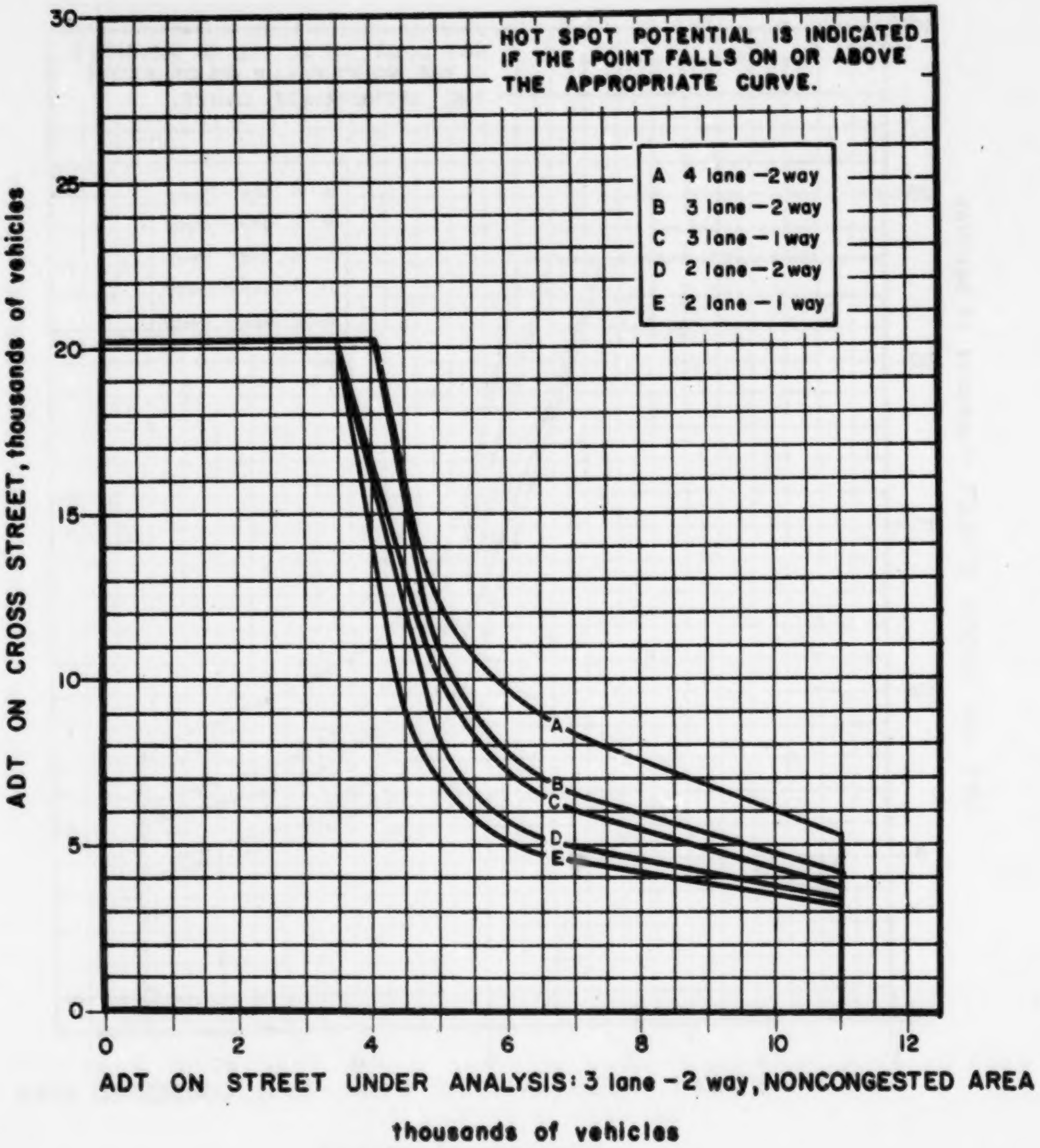

Figure 4. Analysis at signalized intersections of a 3-lane, 2-way street and various cross street configurations in a noncongested area

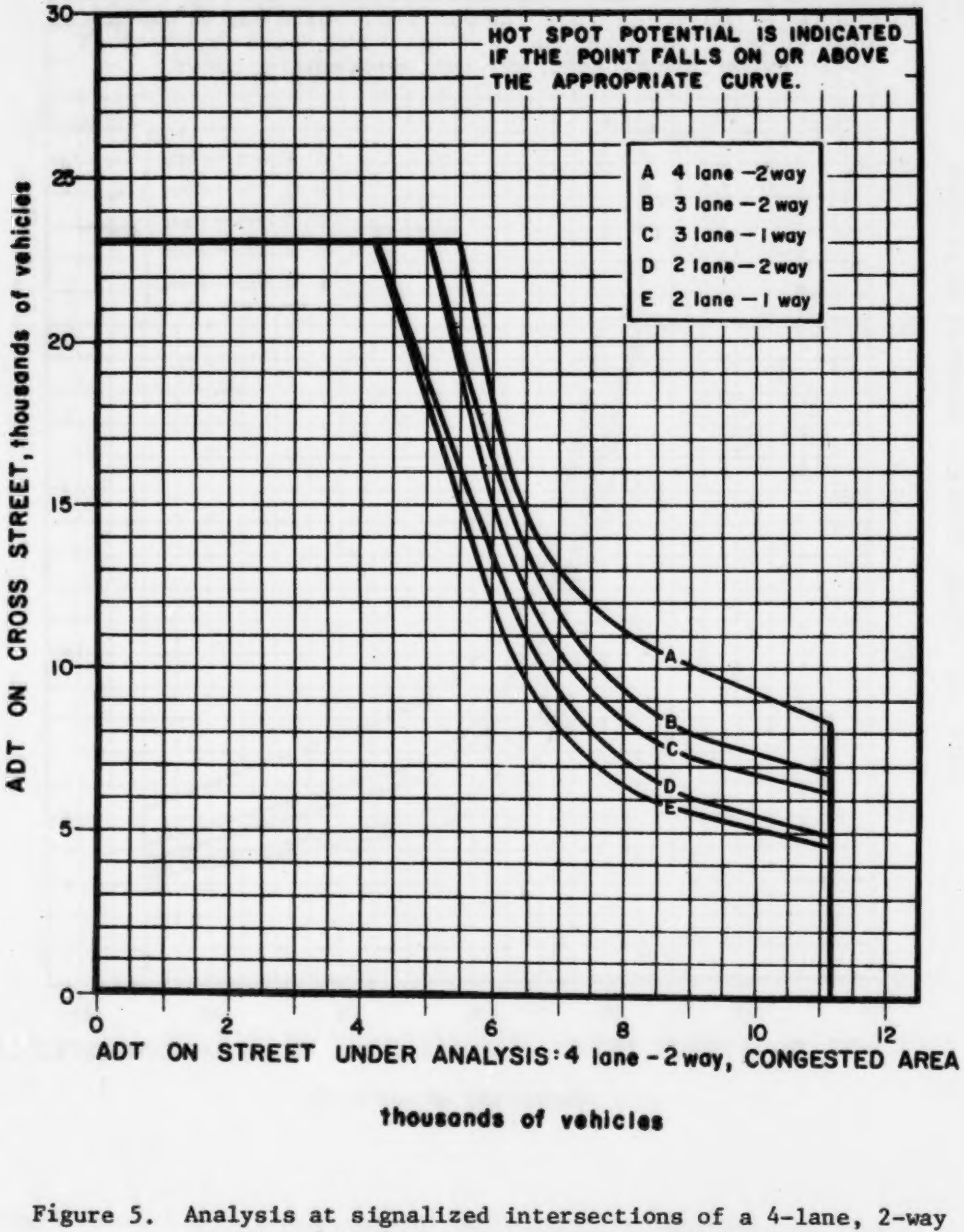

Figure 5. Analysis at signalized intersections of a 4-lane, 2-way street and various cross street configurations in a congested area

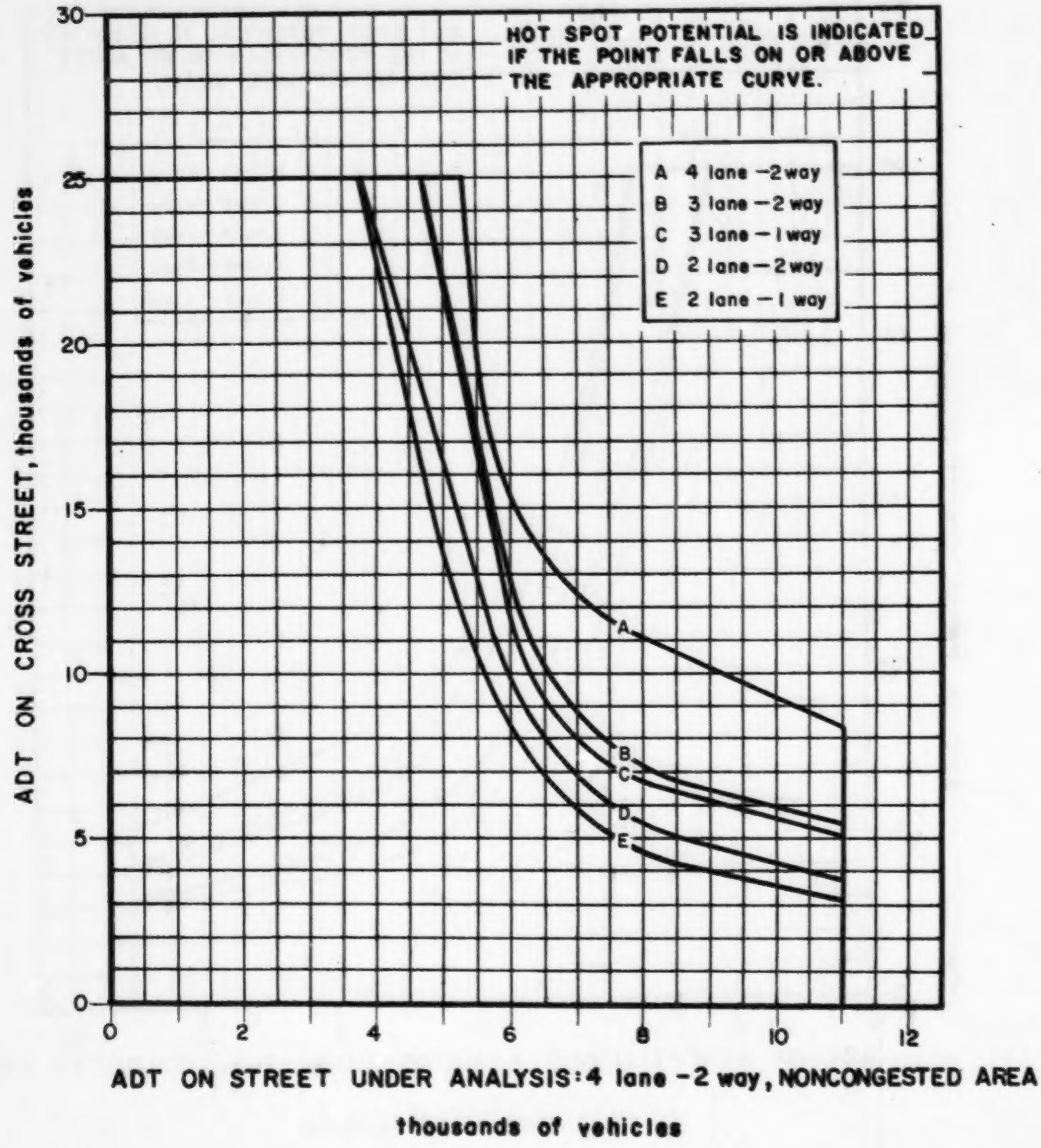

Figure 6. Analysis at signalized intersections of a 4-lane, 2-way street and various cross street configurations in a noncongested area

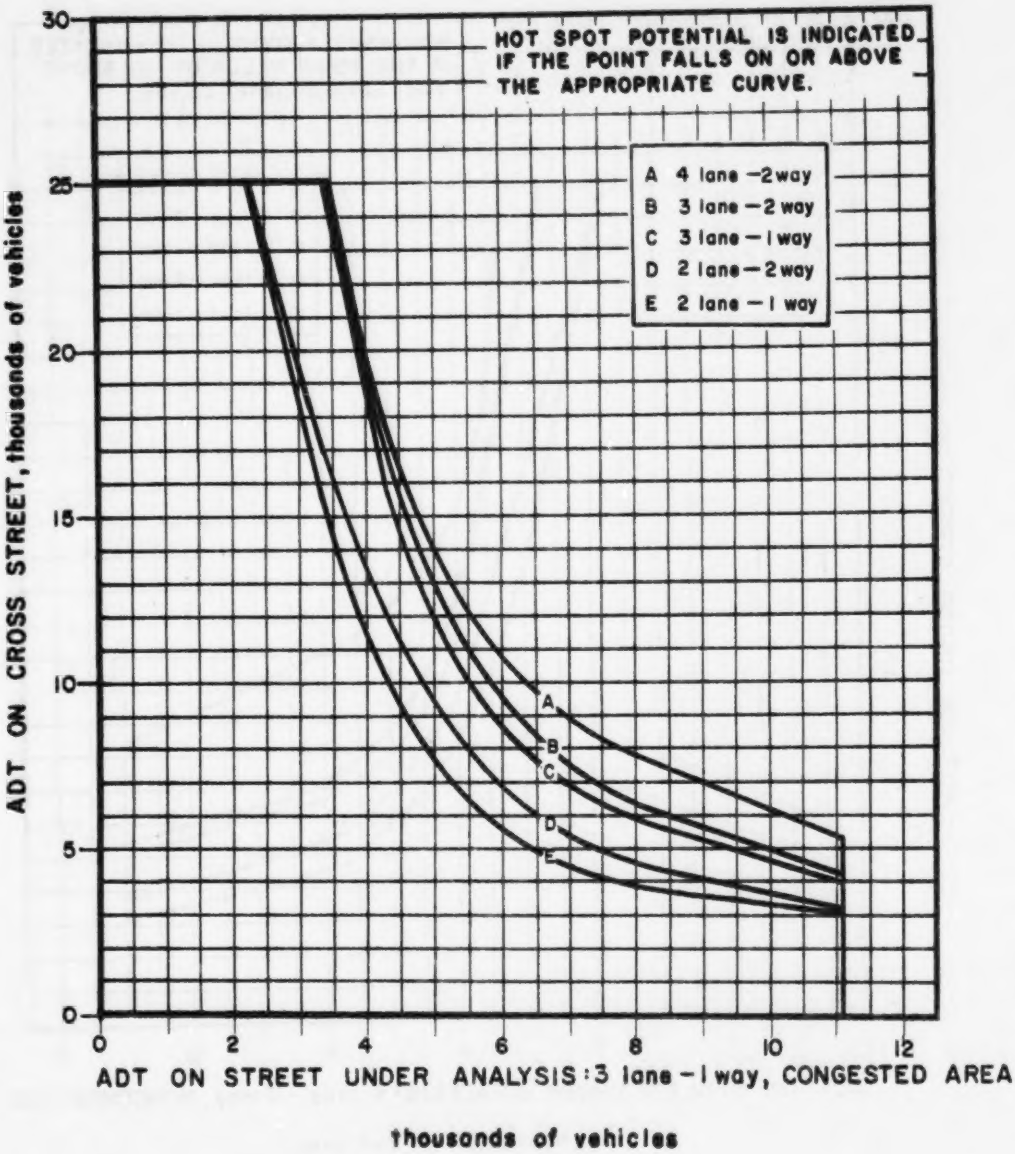

Figure 7. Analysis at signalized intersections of a 3-lane, 1-way street and various cross street configurations

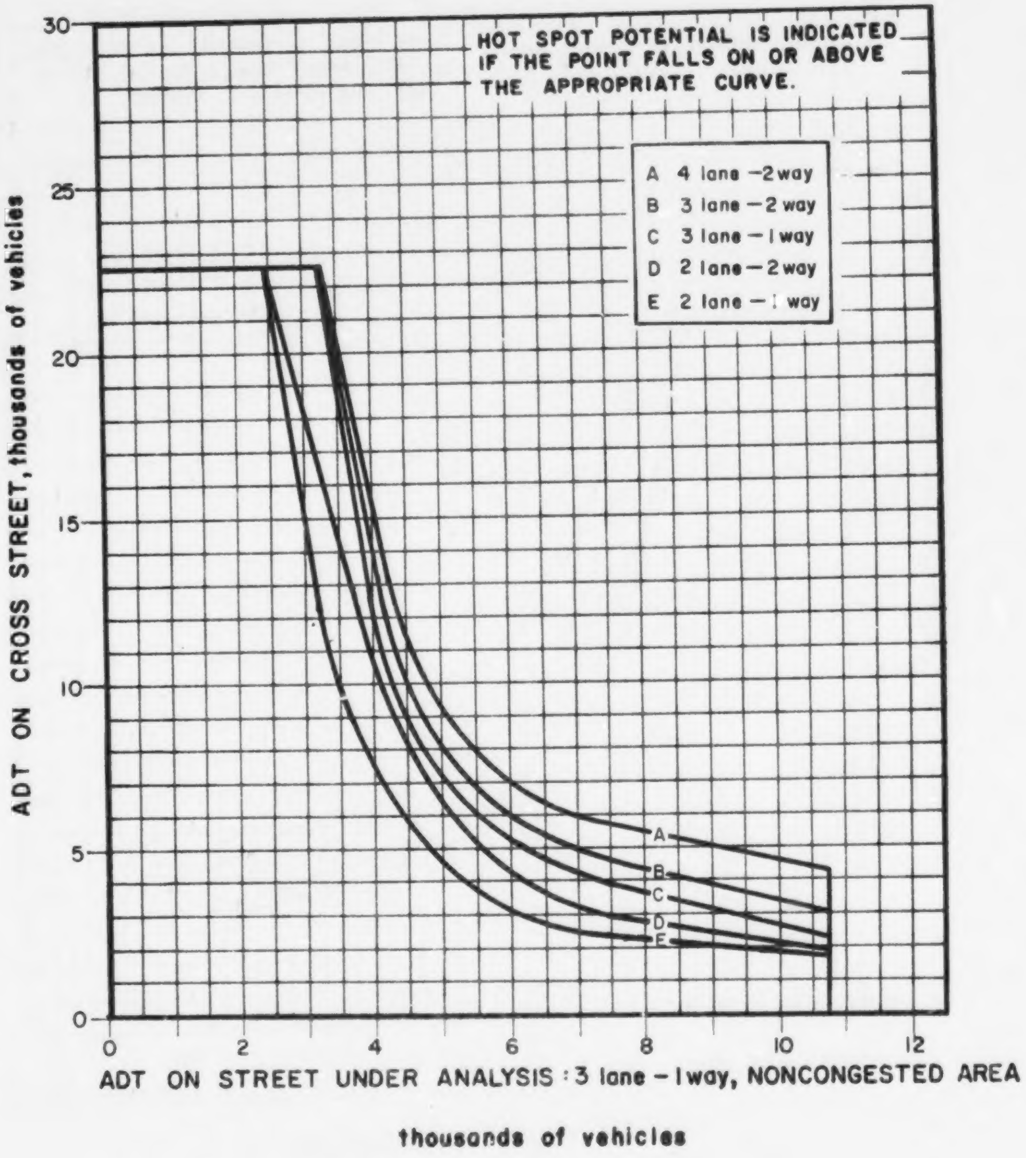

Figure 8. Analysis at signalized intersections of a 3-lane, 1-way street and various cross street configurations for noncongested areas

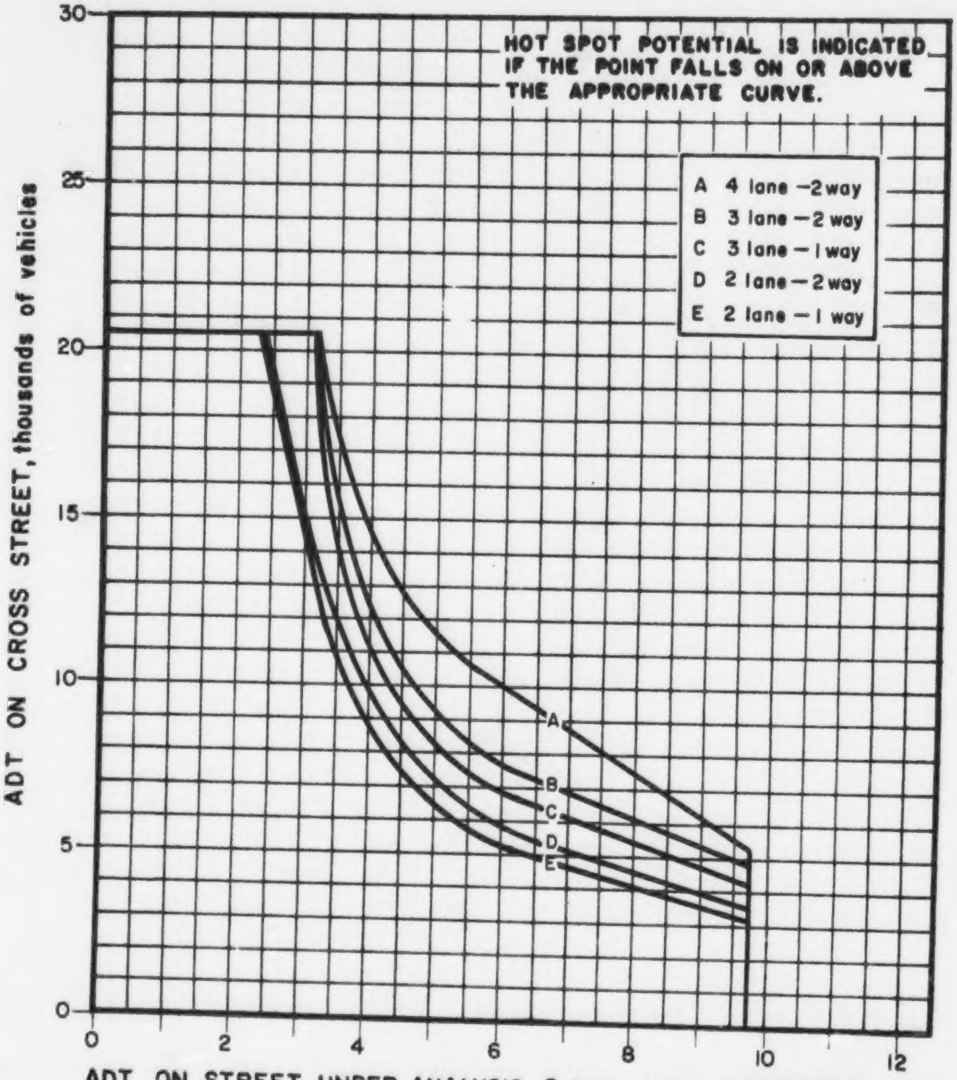

Figure 9. Analysis of signalized intersections of a 2-lane, 1-way street and various cross street configurations

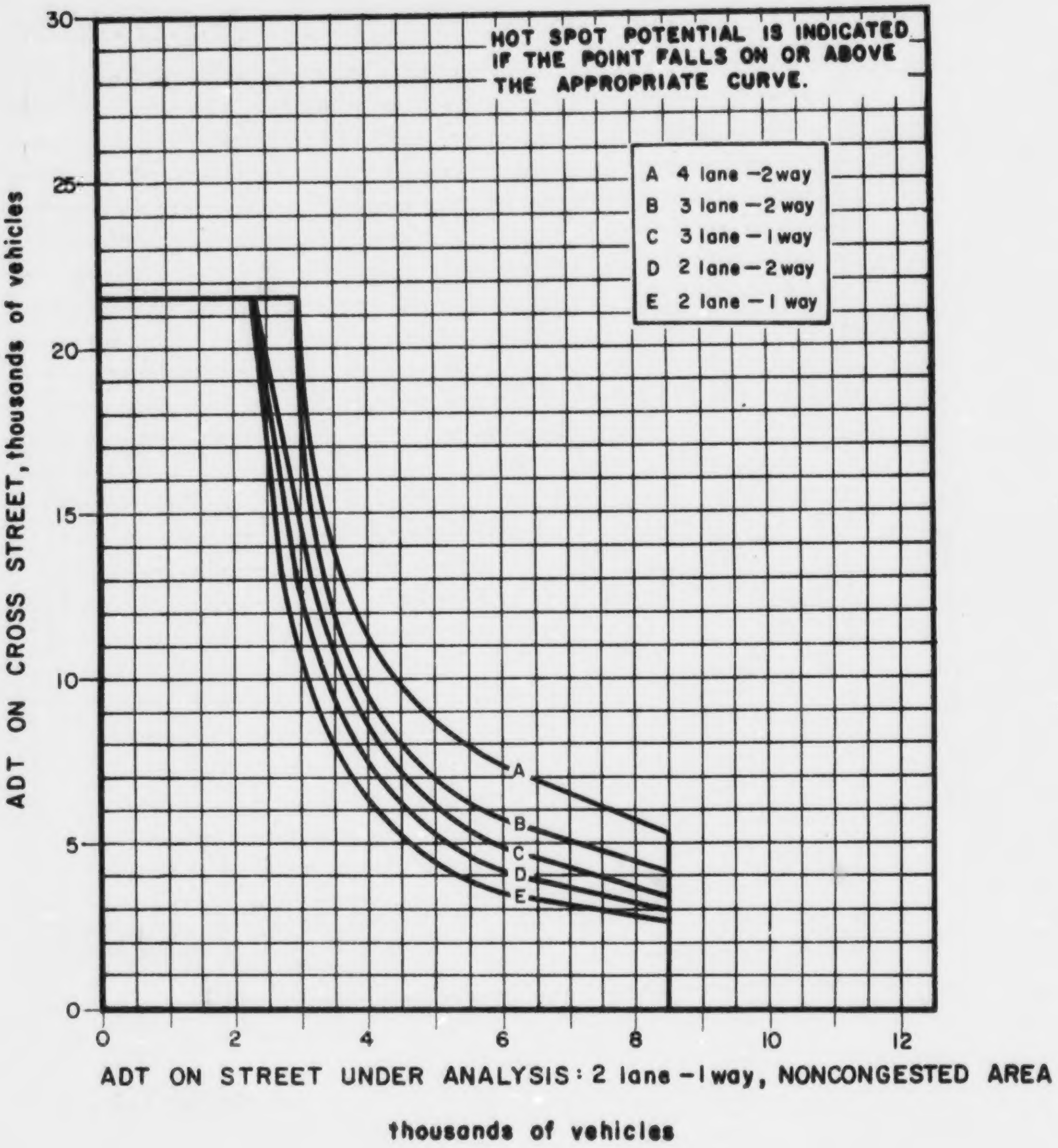

Figure 10. Analysis at signalized intersections for a 2-lane, 1-way street and various cross street configurations in noncongested areas

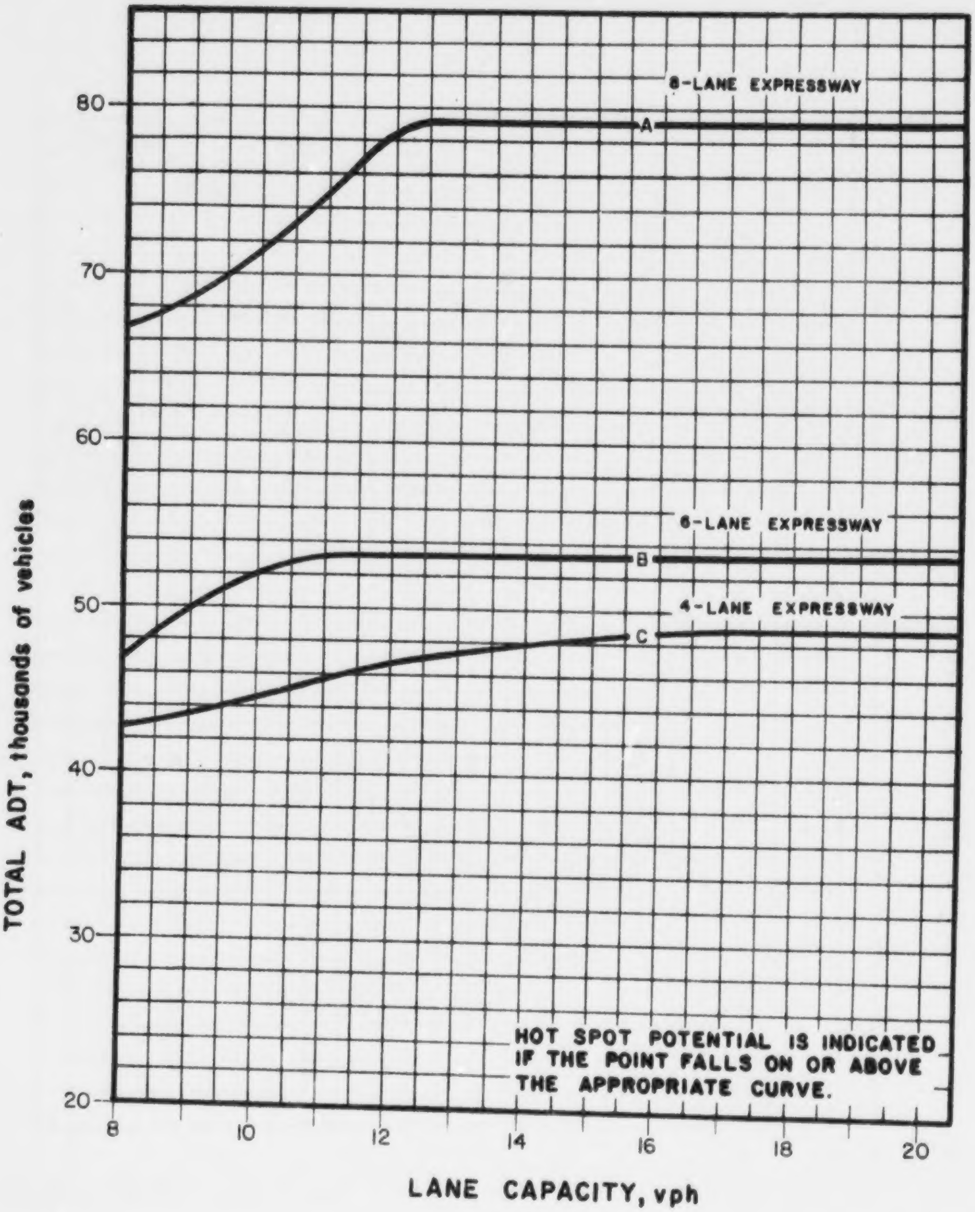

Figure 11. Analysis for uninterrupted flow conditions of controlled access facilities (expressways) for various lane configurations

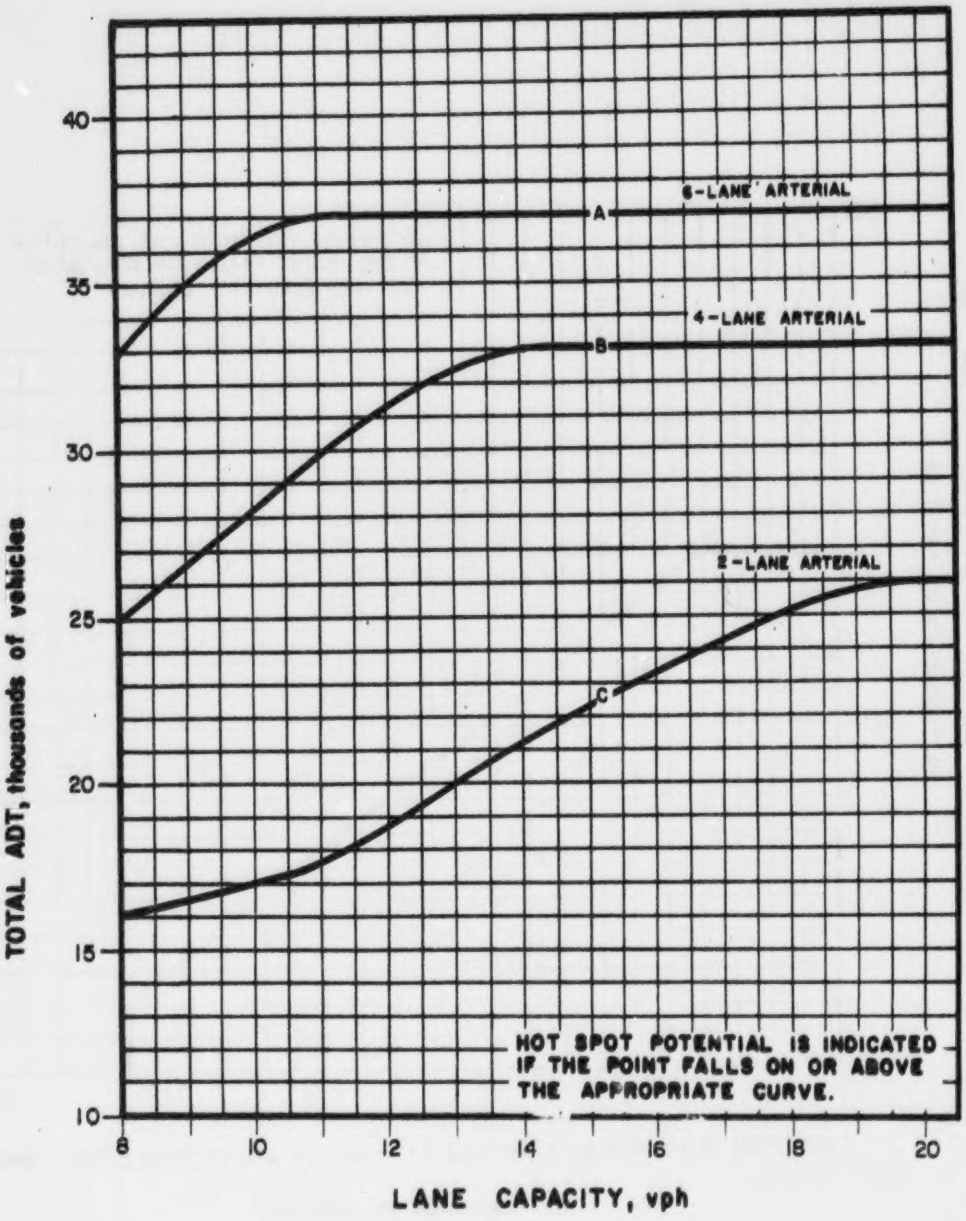

Figure 12. Analysis for uninterrupted flow conditions of uncontrolled access facilities (arterials) for various lane configurations

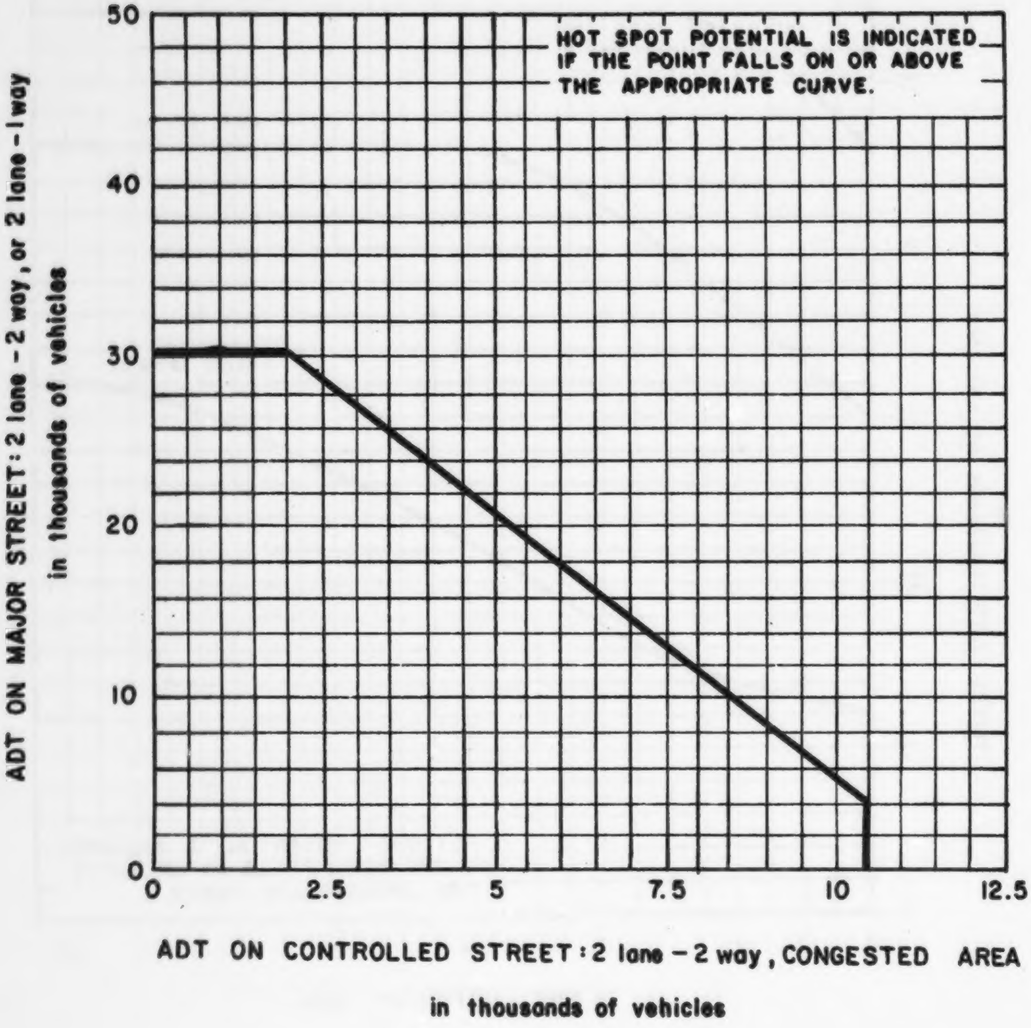

Figure 13. Analysis at nonsignalized intersections of a 2-lane, 2-way controlled street intersecting a 2-lane, 2-way or 2-lane, 1-way major street in a congested area

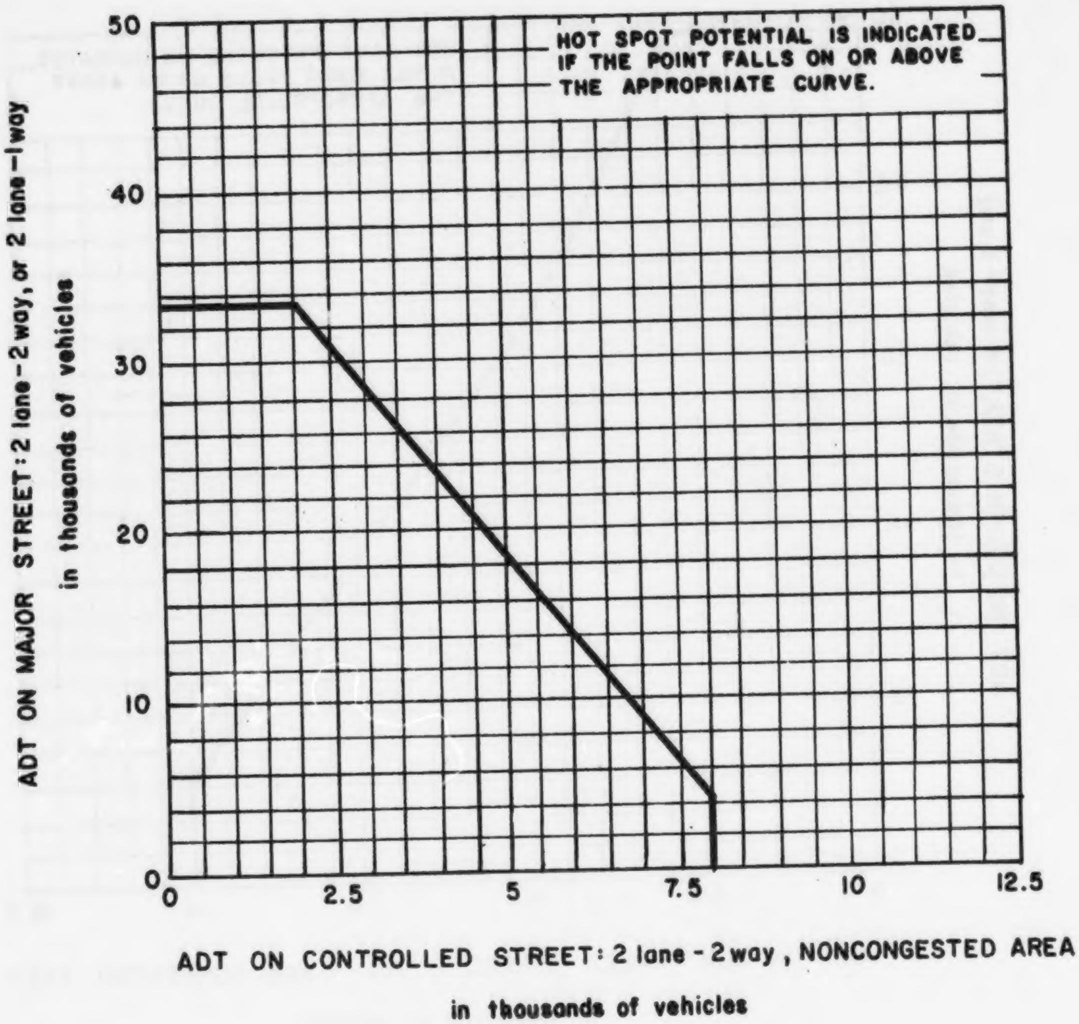

Figure 14. Analysis at nonsignalized intersections of a 2-lane, 2-way controlled street intersecting a 2-lane, 2-way or 2-lane, 1-way major street in a noncongested area

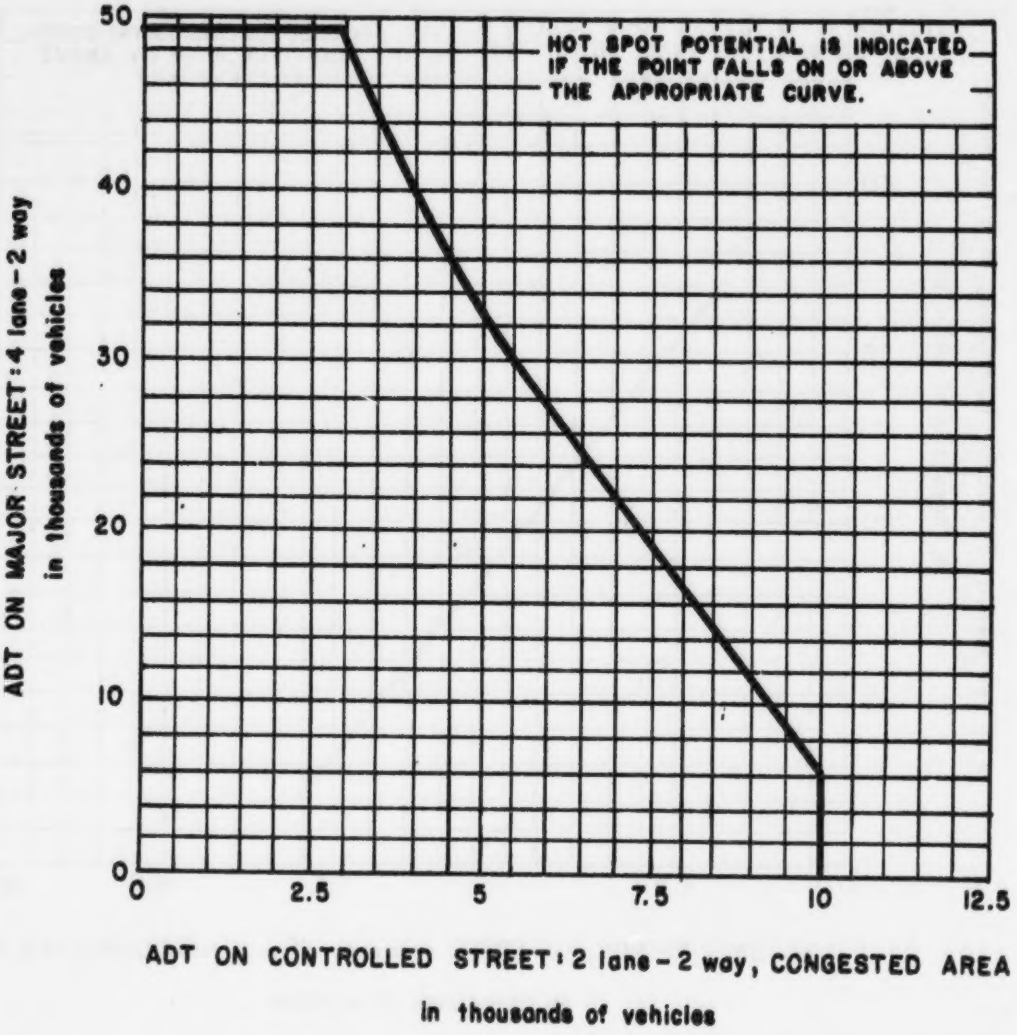

Figure 15. Analysis at nonsignalized intersections of a 2-lane, 2-way controlled street intersecting a 4-lane, 2-way major street in a congested area

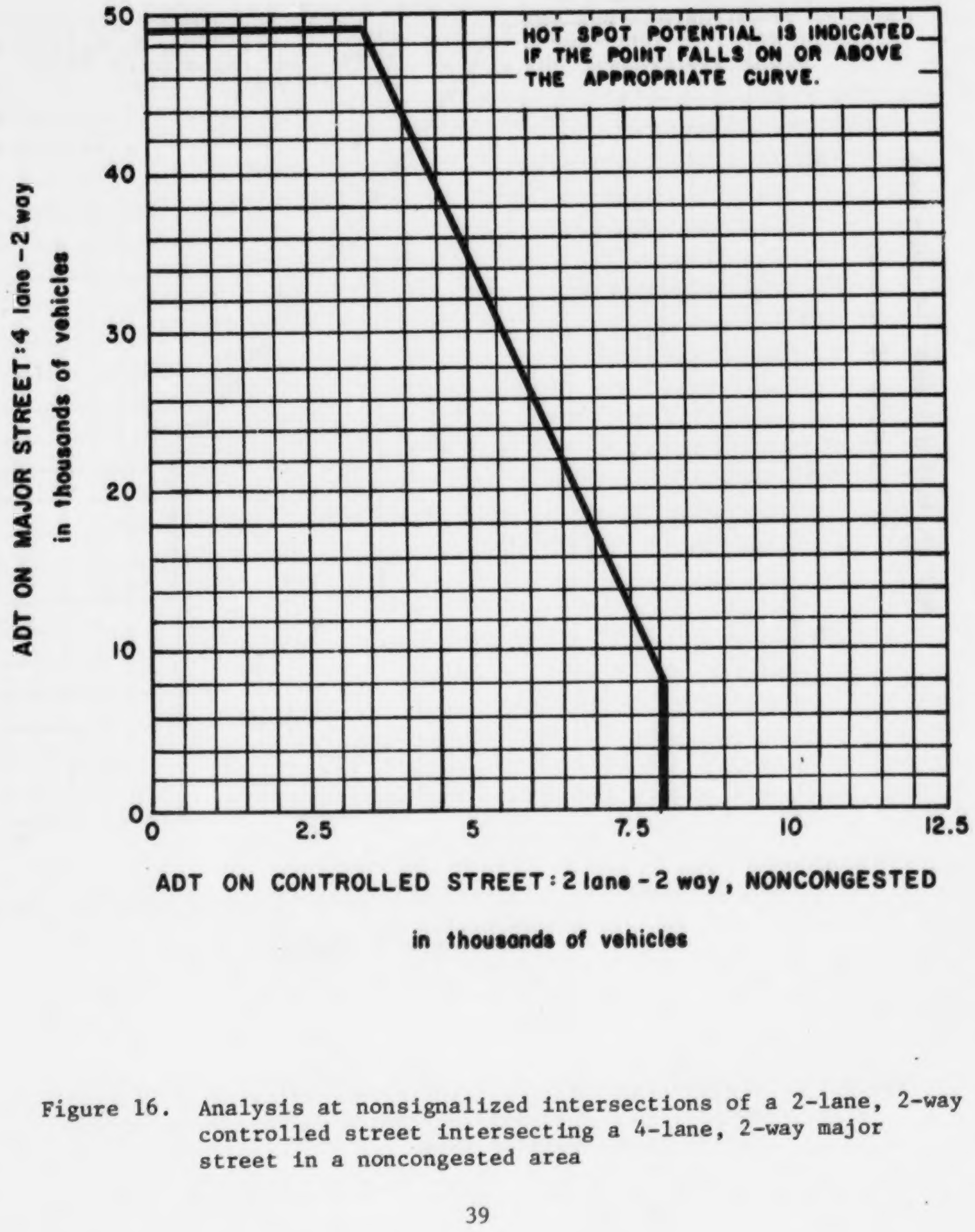

Figure 16. Analysis at nonsignalized intersections of a 2-lane, 2-way controlled street intersecting a 4-lane, 2-way major street in a noncongested area

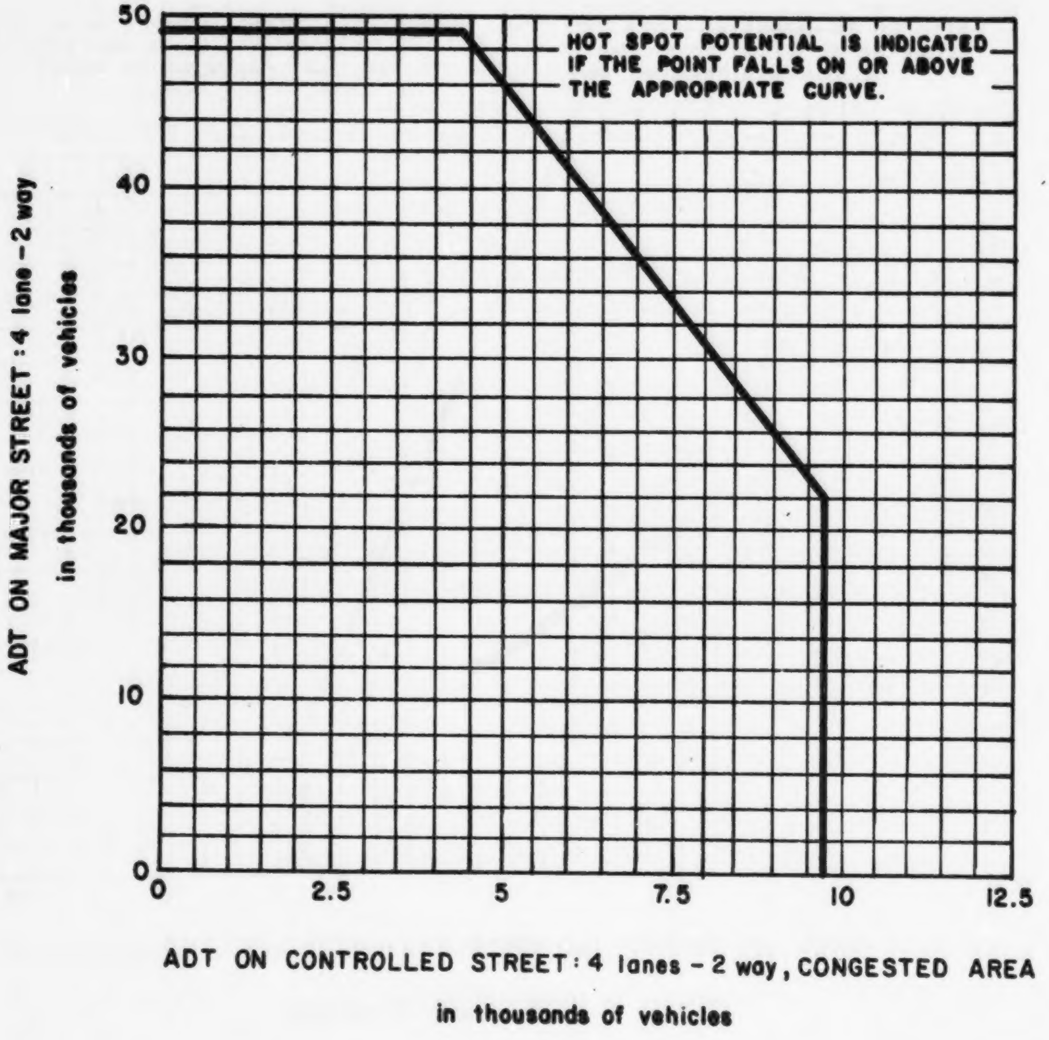

Figure 17. Analysis at nonsignalized intersections of a 4-lane, 2-way controlled street intersecting a 4-lane, 2-way major street in a congested area

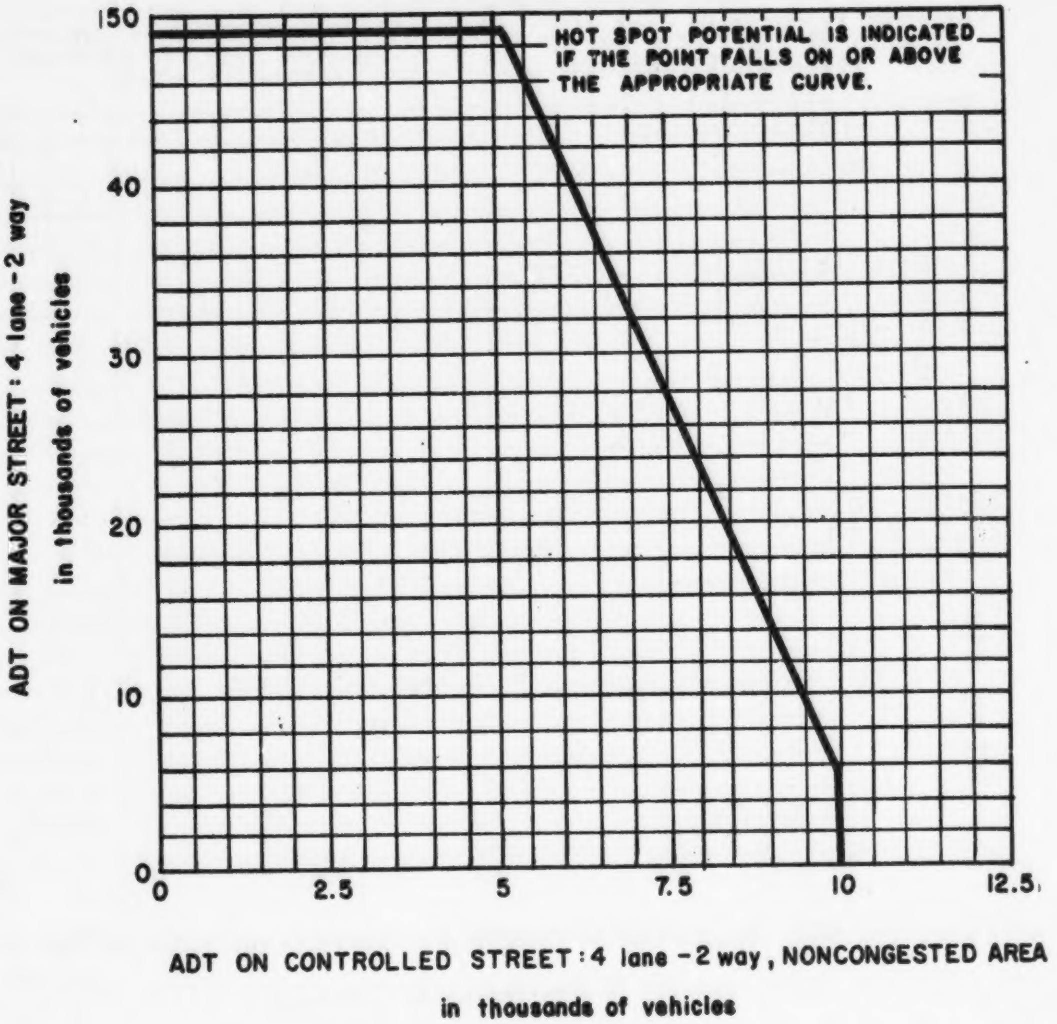

Figure 18. Analysis at nonsignalized intersections of a 4-lane, 2-way controlled street intersecting a 4-lane, 2-way major street in a noncongested area

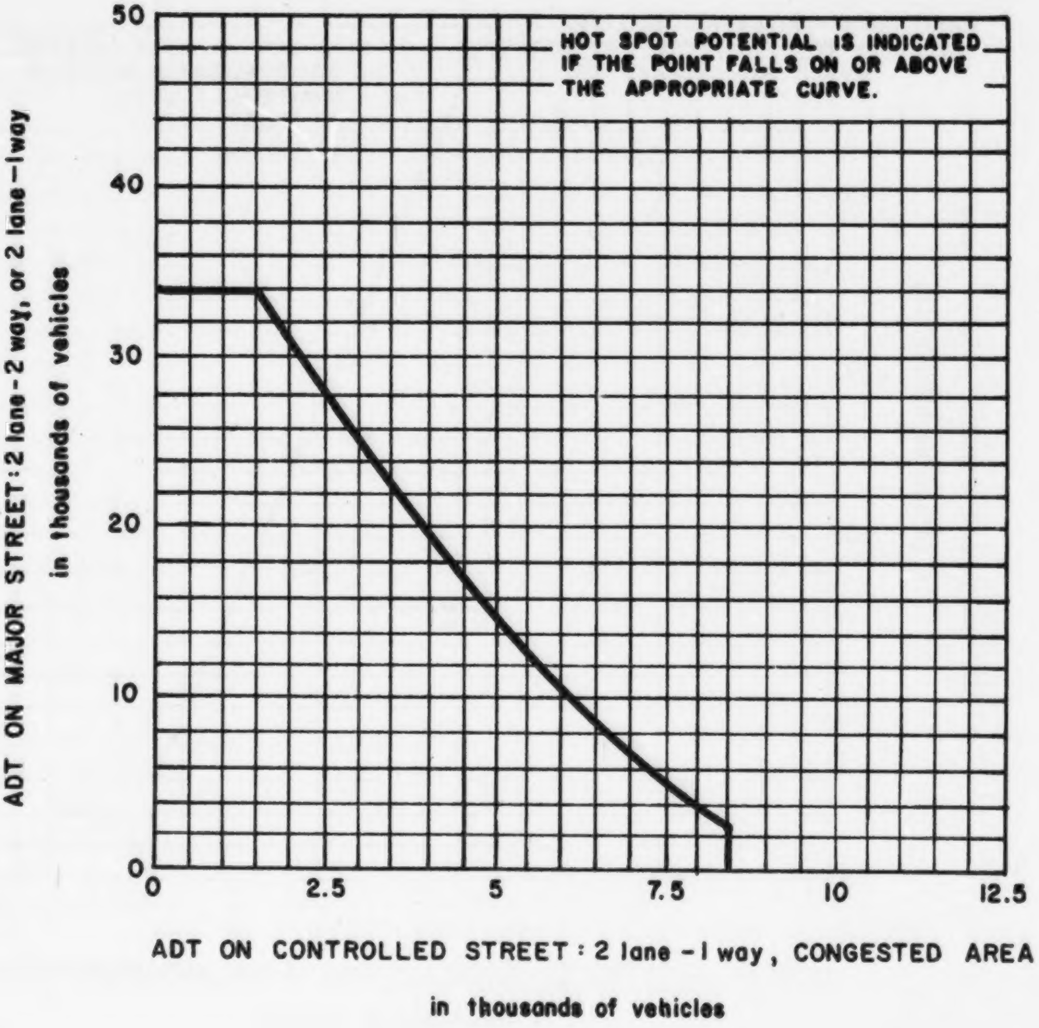

Figure 19. Analysis at nonsignalized intersections of a 2-lane, 1-way controlled street intersecting a 2-lane, 2-way or 2-lane, 1-way major street

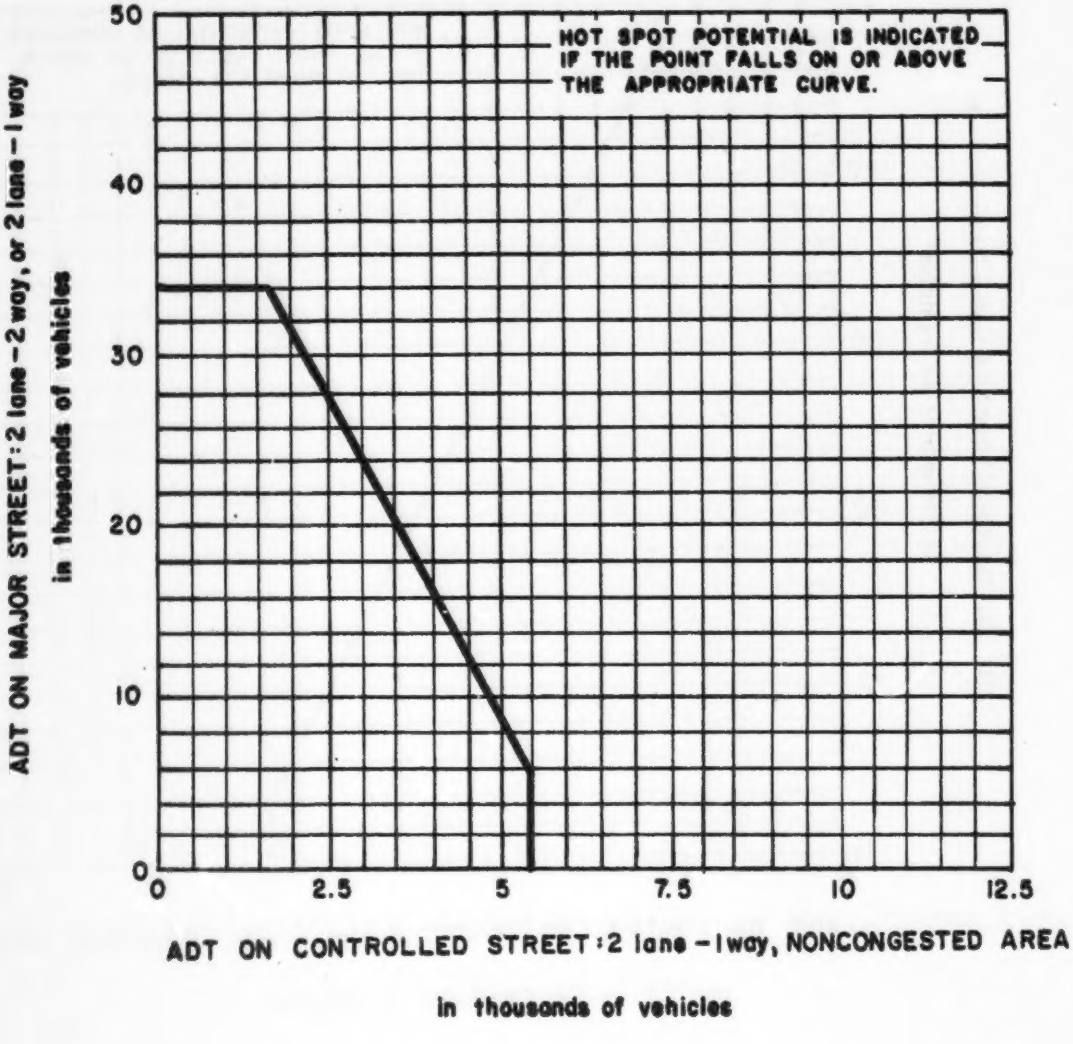

Figure 20. Analysis at nonsignalized intersections of a 2-lane, 1-way controlled street intersecting a 2-lane, 2-way or 2-lane 1-way major street in a noncongested area

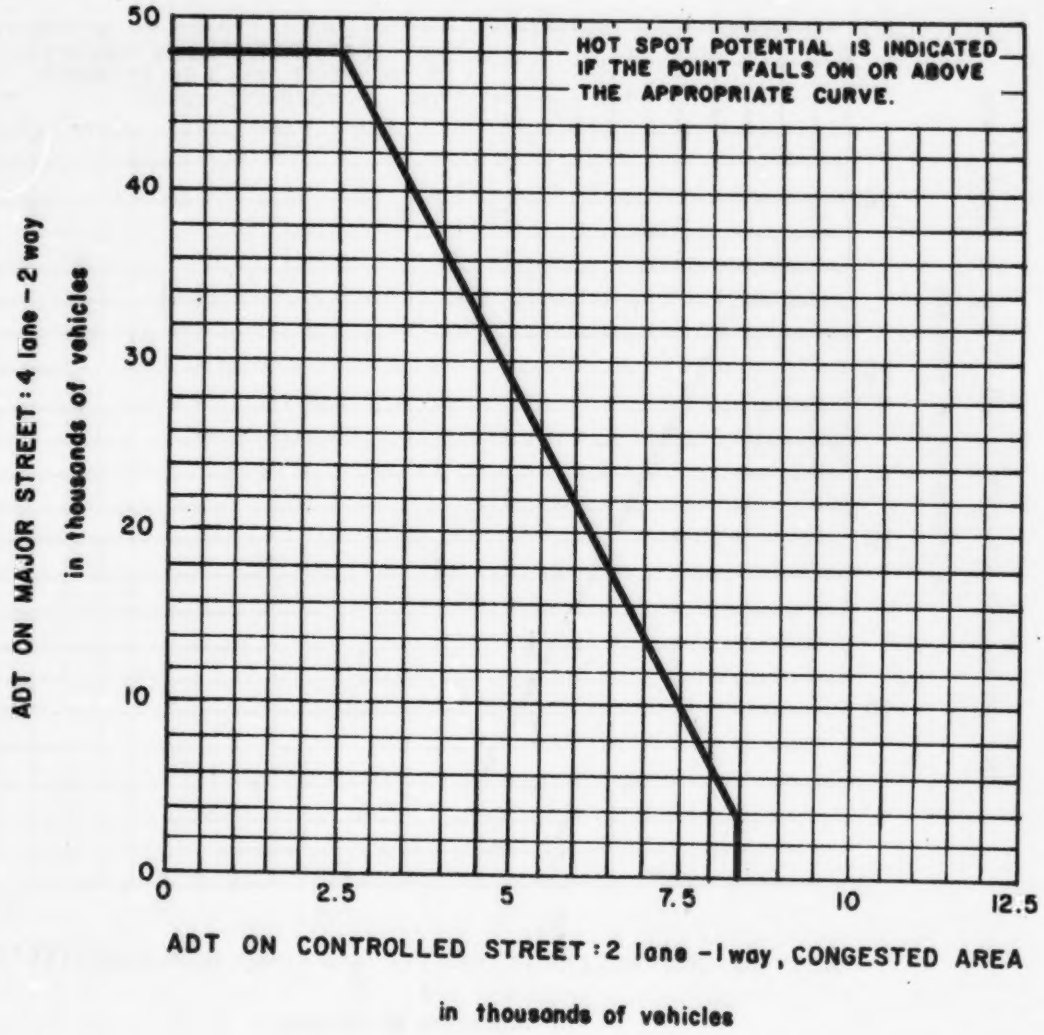

Figure 21. Analysis at nonsignalized intersections of a 2-lane, 1-way controlled street intersecting a 4-lane, 2-way major street

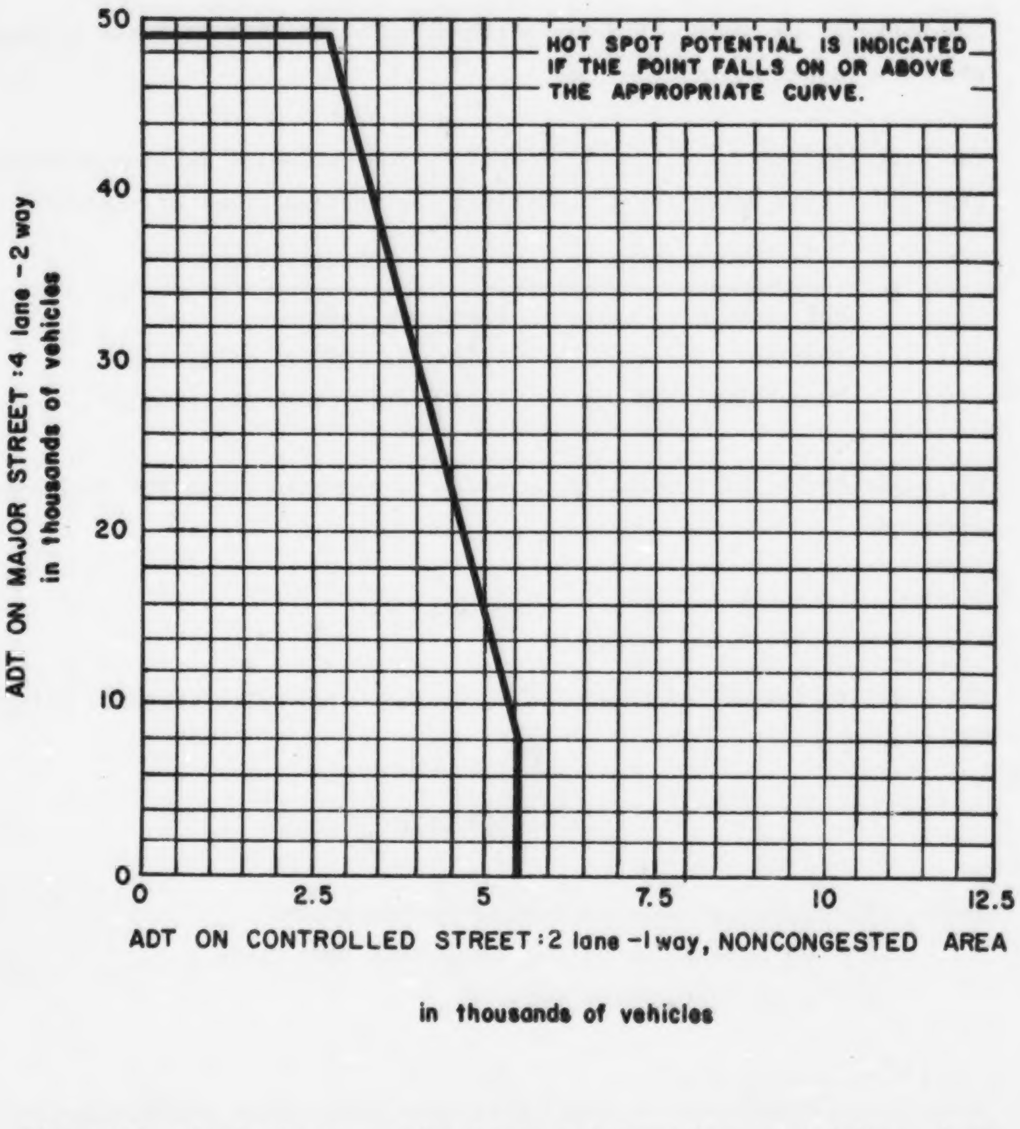

Figure 22. Analysis at nonsignalized intersections of a 2-lane, 1-way controlled street intersecting a 4-lane, 2-way major street in a noncongested area

D. METHODS OF ESTIMATING ROADWAY CAPACITY

This section provides a methodology for calculating roadway or lane capacities, based on the Highway Capacity Manual, for use in the hot spot screening procedures.

The methodology developed here is conservative in that it tends to underestimate capacity.

The Highway Capacity Manual (1965) gives the following maximum uninterrupted flow capacities under ideal conditions for various types of roadways:

Highway type	Capacity (vph)
Multilane	2,000 per lane
Two-lane, two-way*	2,000 total (both directions)
Three-lane, two-way	4,000 total (both directions)

The capacity, C, of a multilane roadway is computed using the following equation:

$$C = 2000\ M\ Wf\ T; \qquad (4)$$

the capacity for one direction of a two-lane roadway is computed using the equation:

$$C = 1000\ Wf\ T \qquad (5)$$

where M = number of lanes moving in one direction
Wf = adjustment factor for lane width from Table 2
T = truck factor from Table 3.

---

*This applies primarily to rural locations where speed ranges are quite high; for most urban applications, capacity can be assumed to be about 2000 vehicles per hour for each direction.

Table 2. COMBINED EFFECT OF LANE WIDTH AND RESTRICTED LATERAL CLEARANCE ON CAPACITY AND SERVICE VOLUMES OF DIVIDED FREEWAYS AND EXPRESSWAYS AND TWO-LANE HIGHWAYS WITH UNINTERRUPTED FLOW

Distance from traffic lane edge to obstruction	Adjustment factor, Wf, for lane width and lateral clearance							
	Obstruction of one side of one-direction roadway				Obstructions on both sides of one-direction roadway			
	12-ft lanes	11-ft lanes	10-ft lanes	9-ft lanes	12-ft lanes	11-ft lanes	10-ft lanes	9-ft lanes
Four-lane divided freeway, one direction of travel								
6	1.00	0.97	0.91	0.81	1.00	0.97	0.91	0.81
4	0.99	0.96	0.90	0.80	0.98	0.95	0.89	0.79
2	0.97	0.94	0.88	0.79	0.94	0.91	0.86	0.76
0	0.90	0.87	0.82	0.73	0.81	0.79	0.74	0.66
Six- and eight-lane divided freeways, one direction of travel								
6	1.00	0.96	0.89	0.78	1.00	0.96	0.89	0.78
4	0.99	0.95	0.88	0.77	0.98	0.94	0.87	0.77
2	0.97	0.93	0.87	0.76	0.96	0.92	0.85	0.75
0	0.94	0.91	0.85	0.74	0.91	0.87	0.81	0.70
Two-lane highway, one direction of travel								
6	1.00	0.88	0.81	0.76	1.00	0.88	0.81	0.76
4	0.97	0.85	0.79	0.74	0.94	0.83	0.76	0.71
2	0.93	0.81	0.75	0.70	0.85	0.75	0.69	0.65
0	0.88	0.77	0.71	0.66	0.76	0.67	0.62	0.58

Table 3. AVERAGE GENERALIZED ADJUSTMENT FACTORS FOR TRUCKS ON FREEWAYS AND EXPRESSWAYS, AND 2-LANE HIGHWAYS OVER EXTENDED SECTION LENGTHS

Pt, percentage of trucks, %	Factor, T, for all levels of service Level terrain	 Rolling terrain	 Mountainous terrain
	Freeways and expressways		
1	0.99	0.97	0.93
2	0.98	0.94	0.88
3	0.97	0.92	0.83
4	0.96	0.89	0.78
5	0.95	0.87	0.74
6	0.94	0.85	0.70
7	0.93	0.83	0.67
8	0.93	0.81	0.64
9	0.92	0.79	0.61
10	0.91	0.77	0.59
11	0.89	0.74	0.54
14	0.88	0.70	0.51
16	0.86	0.68	0.47
18	0.85	0.65	0.44
20	0.83	0.63	0.42
	Two-lane highways		
1	0.99	0.96	0.90
2	0.98	0.93	0.82
3	0.97	0.89	0.75
4	0.96	0.86	0.69
5	0.95	0.83	0.65
6	0.94	0.81	0.60
7	0.93	0.78	0.57
8	0.93	0.76	0.53
9	0.92	0.74	0.50
10	0.91	0.71	0.48
12	0.89	0.68	0.43
14	0.88	0.64	0.39
16	0.86	0.61	0.36
18	0.85	0.58	0.34
20	0.83	0.56	0.31

E. EXAMPLE

An example is provided here of the screening of a signalized intersection - School Street at Lexington Street in Waltham, Massachusetts. The data required includes traffic volume and a description of the street layout. The volume data in the form of average daily traffic (ADT) were obtained from local sources, while the layout of the streets was determined from field reconnaissance. The volumes (proejcted to the winter of 1982 to 1983) are:

Lexington Street, north approach	14,000
Lexington Street, south approach	10,000
School Street, east approach	8,000
School Street, west approach	9,000

Both School Street and Lexington Street provide a total of two lanes and operate as two-way streets.

The street names are entered in Part I of the worksheet, as shown in Figure 23. Owing to the observed pedestrian activity, the relatively narrow pavement width, and the influence of nearby intersections, it has been determined that the intersection should be classified as being in a congested area. This fact is recorded in Part II of the worksheet. The intersection is neither complex nor a special case; this is recorded in Part III.

The actual analysis of hot spot potential begins by recording the appropriate street identification, volume data, and street configuration information in Part IV. These are entered in columns a, b, and c, respectively, as shown in Figure 23.* The ADTs and the configuration of the cross street (School Street) approaches are entered in the appropriate columns - ADTs in columns d and h, the configurations in columns e and i. In this case, both Lexington and School Streets have 2-lane 2-way (2L/2W) configurations.

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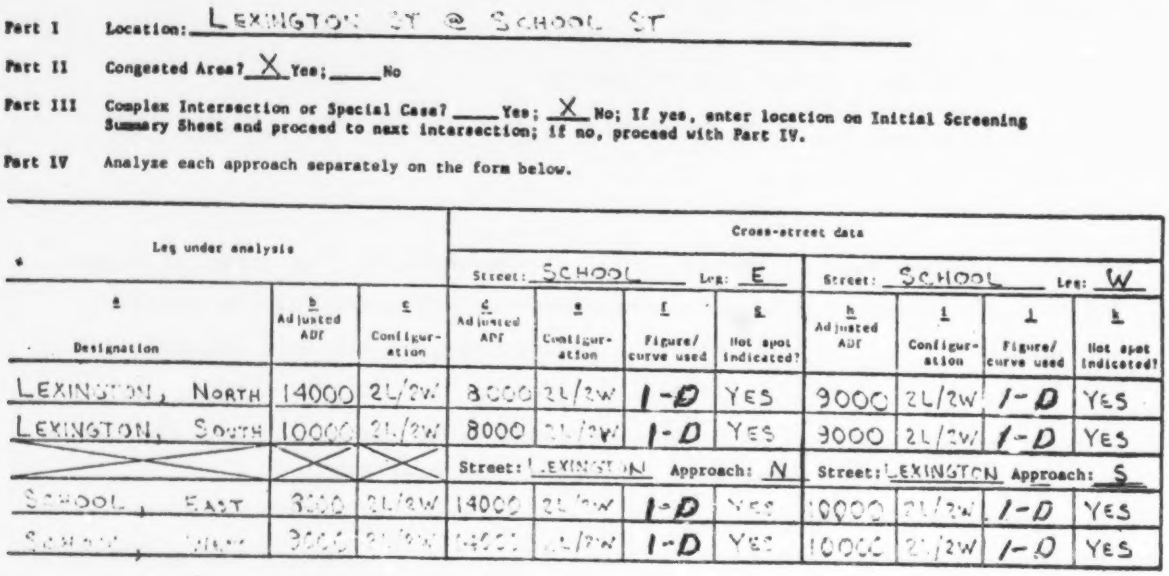
*It should be noted that all approaches to an intersection are generally analyzed, but for this example, the analysis of only one approach will be described.



Part I Location: LEXINGTON ST @ SCHOOL ST

Part II Congested Area? X Yes; ____ No

Part III Complex Intersection or Special Case? ____ Yes; X No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each approach separately on the form below.

Leg under analysis			Cross-street data							
			Street: SCHOOL Leg: E				Street: SCHOOL Leg: W			
a Designation	b Adjusted ADT	c Configuration	d Adjusted ADT	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT	i Configuration	j Figure/ curve used	k Hot spot indicated?
LEXINGTON, NORTH	14000	2L/2W	8000	2L/2W	1-D	YES	9000	2L/2W	1-D	YES
LEXINGTON, SOUTH	10000	2L/2W	8000	2L/2W	1-D	YES	9000	2L/2W	1-D	YES
			Street: LEXINGTON Approach: N				Street: LEXINGTON Approach: S			
SCHOOL, EAST	9000	2L/2W	14000	2L/2W	1-D	YES	10000	2L/2W	1-D	YES
SCHOOL, WEST	9000	2L/2W	14000	2L/2W	1-D	YES	10000	2L/2W	1-D	YES

Figure 23. Example screening

The next step is to determine which screening curve is appropriate for the specified conditions. Figure 1 provides curves for the analysis of a 2-lane 2-way street (in this case, Lexington Street) in a congested area for signalized intersections. Because School Street is a 2-lane 2-way street, curve D in Figure 1 is selected and this is recorded in columns f and j.

To determine the hot spot potential for the Lexington Street north approach, the point corresponding to 14,000 on the abscissa and 8,000 on the ordinate is plotted in Figure 1. Since this point is above and to the right of curve D, hot spot potential is indicated for the Lexington Street, north approach.

SECTION III

HOT SPOT VERIFICATION

A. OVERVIEW OF HOT SPOT VERIFICATION

The verification process is a followup to the screening of an area. Conceptually, the technique involved is identical to that used for the screening. It assumes an explicit relationship between air quality, traffic operating characteristics, and physical characteristics of an intersection, for particular meteorological conditions. Therefore, if both traffic and physical characteristics are determined, and a particular set of meteorological conditions assumed, estimates of the resulting air quality can be made. Again, these estimates are made using a series of curves that relate various traffic and roadway characteristics to resulting air quality.

In discussing the verification process it is necessary to consider the three basic elements of the procedure - these include the data required, the curves to be used, and a set of standard worksheets to be used for performing and recording the verification of potential hot spots.

1. Data Requirements

While in the screening process it was emphasized that maximum use should be made of existing general traffic data, the verification process requires current data specific to each site analyzed. However, existing data may be used if they are determined to be representative of current traffic conditions and of sufficient detail. The required data are outlined below, and summarized in Table 4. *In all cases observed data should supersede* *suggested estimates herein when these data apply to the locations being modeled.* Specific guidance for estimates is given in the worksheet instructions.

Table 4. SUMMARY OF DATA REQUIREMENTS FOR HOT SPOT VERIFICATION

Data element	Remark
Location sketch	The sketch should dimension the traffic engineering features, identify the geometry of the location and identify traffic operational constraints.
Traffic volume	Peak hour volume projected to the analysis year for the busiest winter season month.*
Vehicle speed	Estimate of operating cruise speed.
Receptor separation	The distance between the receptor site and the centerline of the traffic stream.
Vehicle classification	Distribution of traffic by vehicle type: LDV, LDT, HDV-G, HDV-D.
Traffic signal operation	Signal timing and phasing at signalized intersections.
Vehicle mode operation	Distribution of vehicles by operating mode: cold-start, hot-start, stabilized.
Temperature	Ambient temperature representative of winter days.

a. Location Sketch - A sketch should be prepared of each location requiring verification. This sketch should show:

- the approximate geometry of the location
- the number of approach and departure lanes on each roadway if the site is an intersection, or just the number of lanes if the site is an expressway or mid-block location
- the width of each lane, shoulder, median, and channelizing island

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*The reader should refer to the discussion on page 34 of Volume I regarding critical season.

- the locations within each site where curb parking is permitted, where bus stops and taxistands are located, and the width of such parking lanes
- the location of the worst-case receptor site (see part d below)
- pertinent notes regarding observations as to the operation of the facility.

b. Traffic Volume - Peak hour volume data (or projected data) averaged per lane are required for all streets and highways analyzed. These volumes should be representative of the busiest month from November through March. This implies that a statistical data base must also be available from which projections are made. The directional split of peak hour traffic is also required since computations of carbon monoxide concentrations are performed on a traffic stream basis.

c. Vehicle Cruise Speed - Estimates of the cruise speed of freely flowing vehicles and vehicles departing from signalized intersections must be made. These can be based on actual field studies or through estimates based on observed operating characteristics and surrounding land use. Several figures and tables, which appear later in this section, have been provided to aid in making these estimates.

d. Roadway/Receptor Separation Distance - The separation distance, x, between the receptor site and traffic streams in both directions (for both uninterrupted flow locations and intersections) is required. This is the minimum perpendicular distance in meters from the centerline of the traffic stream to a line parallel to the roadway drawn through the receptor site; that is, the offset distance from the centerline of the traffic stream (all lanes in one direction of travel) to the centerline of an adjacent sidewalk or edge of right-of-way.

For intersections, the receptor is a point defined by the offset distance from the centerline of the traffic stream, and a specified back distance from the intersection. The distance back from the intersection is a function of the queue length that develops. The user is not required to compute the distance nor is he required to compute queue length; rather, empirical relationships between volume demand and queue length are used implicitly so that volume and traffic signal parameters (as will be explained later) are the only inputs required.

e. Vehicle Classification Data - Another data requirement is the distribution of traffic by vehicle type. This is usually developed for specific highway classifications such as expressways, major arterials, minor arterials, etc. The vehicle classifications that should be identified include:

- light-duty vehicles (passenger cars) - LDV
- light-duty trucks (panel and pickup trucks, light delivery trucks - usually all 2-axle, 4-wheel trucks) - LDT
- heavy duty, gasoline-powered trucks - HDV-G
- diesel-powered trucks - HDV-D.
- motorcycles - MC

These data may be available for a community where recent comprehensive transportation planning programs have been accomplished.

f. Traffic Signal Data - A necessary element in the verification of hot spot potential at signalized intersections is the ratio of the green time allocated to each approach, to the total cycle length (G/Cy). This ratio can be determined from records or design plans if the installation is of the fixed-time type but if actuated control is utilized, the ratio must be computed based on the actual peak hour volumes.

Where actuated pedestrian signals are used, estimates should be made of the number of times during the peak hour that the actuated pedestrian phase is called. Also, where turning lanes are provided and these lanes are subject to interference from stopped through traffic, estimates of this interference should be made. The green time allocated to the approaches affected by these occurrences then must be adjusted. (Refer to worksheet for worksheets for guidance in estimating G/Cy.)

g. Percentage of Cold-Start Vehicles - Estimates of the proportion of cold-operating vehicles in the traffic stream during the peak hour are required. This is a difficult statistic to determine for specific locations; therefore it is recommended that a very general approach be taken involving the use of the results of a recently completed study[9] that focused on determining the proportion of cold-operating vehicles in numerous traffic streams in two U.S. cities. This study concluded that the distribution of cold-operating vehicles is a function of the time of day and the type of location. For instance, it was determined that the fraction of vehicles operating in the cold mode during the morning in the CBD was substantially different from the fraction operating at the CBD during the evening; also, the fraction of cold-operating vehicles at locations in the CBD differed significantly from the fraction in say, residential areas for the same time-period. In the absence of data specific to a location undergoing hot spot analysis, it is recommended that the fraction of vehicles operating in the cold mode be estimated using the information in the worksheet instructions.

h. Percentage of Hot-Start Vehicles - The proportion of vehicles operating in the hot-start mode must also be estimated. This parameter, like the cold-mode fraction, is not easily determined. The actual impact of hot-start vehicles is not nearly as significant as the cold-start fraction, however. Again, guidance is provided in estimating this parameter in the worksheets.

i. Temperature - Ambient temperature has a significant effect on the emissions from cold-operating vehicles and the time necessary to achieve normal operating temperature. Colder temperatures produce higher emission rates. Since a worst-case analysis is being performed, a temperature typical of that during the peak traffic hour on cold winter days (or critical season) should be used.

j. Street Canyons - At some midblock locations and intersections in urban areas, a vortex motion may develop in the wind circulation between tall buildings. This occurs in areas referred to as "street canyons." A schematic of this windflow pattern is depicted in Figure 24. A vortex will form when two conditions exist; first, the roadway/wind angle, θ, must be at least 30°, and second, the penetration depth, δ, of the rooftop wind into the street canyon, must be less than the average height, H, of the upwind buildings. In the analysis of hot spots, an assumption can be made outright that the roadway/wind angle is 30°, but the rooftop wind penetration depth must be calculated using the equation:

$$\delta = 7\ (kW/u)^{\frac{1}{2}}$$

where k = turbulent diffusivity of momentum $\simeq 1\ m^2/sec$

W = street canyon width (building-to-building), m

u = rooftop windspeed, m/sec

7 = an empirical nondimensional constant.

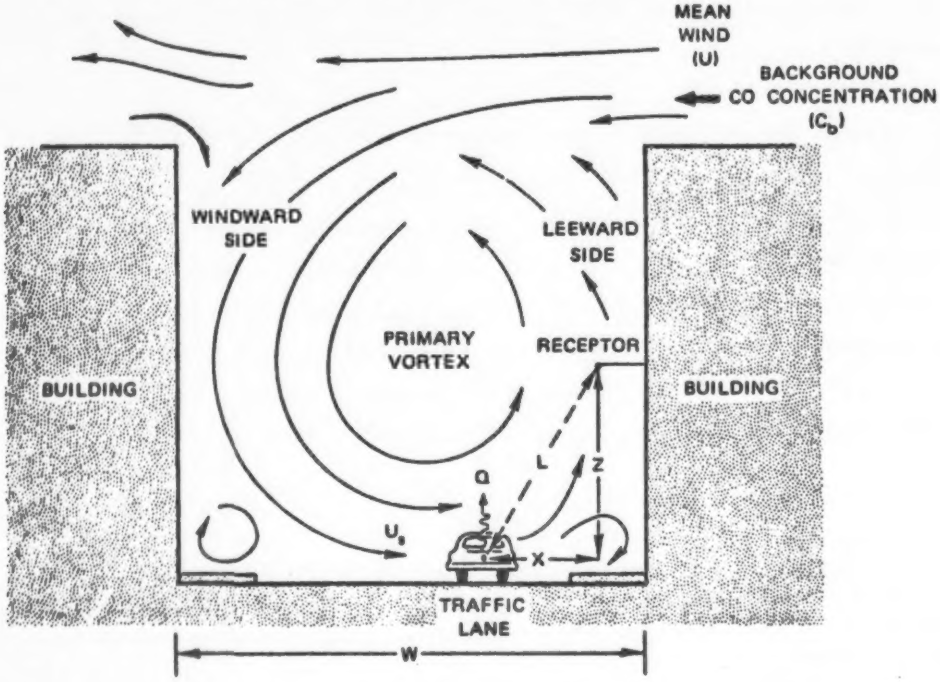
MEAN WIND (U)
BACKGROUND CO CONCENTRATION (C_b)
WINDWARD SIDE
LEEWARD SIDE
PRIMARY VORTEX
RECEPTOR
BUILDING
BUILDING
Q
L
Z
U_s
X
TRAFFIC LANE
W

Figure 24. Schematic of cross-street circulation between buildings

Again, in these Guidelines, the criterion for roadway/wind angle can be assumed to be met so that the user must only check the building height and penetration depths.

When the vortex forms, dispersion of CO along roadways is different compared with dispersion along open areas. To reflect these different dispersion characteristics, a separate technique is introduced into this analysis that better describes street canyon dispersion. This is accomplished by introducing the street canyon criterion for penetration depth in the worksheets (again, the roadway/wind angle criterion is assumed to be met), and special procedures are defined throughout if a street canyon situation is indicated.

When applying the street canyon calculations to an intersection, only the main link (determined beforehand) is considered.* Since the CO concentration computed using the street canyon procedure may be lower than if the nonstreet canyon procedure is used, it may be useful in many instances to use both techniques so that hot spot potential can be assessed more completely.

k. Miscellaneous Data - This category includes information relative to planned projects that will directly impact traffic or travel within the study area in the near future. These could involve alteration to the street network, (e.g., adding or deleting major arterials or expressways, revising circulation patterns, changing signal systems, etc.), or the development of programs to create mode shifts, (e.g., improving bus service for commuters). The expected effect on traffic volumes must be considered where these possibilities exist.

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*It is noted that the affects of other nearby links in terms of concentrations at receptors located in a street canyon have not been investigated thoroughly, and thus are assumed at this time to have minimal impact at the receptor.

Another area of consideration is the effect of programs that will have an impact on automotive emissions, such as mandatory inspection and maintenance programs. Where such programs are in effect or are anticipated, their impacts should be estimated.

B. WORKSHEETS AND INSTRUCTIONS FOR HOT SPOT VERIFICATION

The following pages present detailed instructions for performing hot spot verification. Included are separate worksheets and instructions for analyzing signalized intersections, STOP-sign controlled intersections, free-flowing sections of arterial streets, and expressways. It is suggested that all signalized intersections be analyzed first, followed by analyses of free-flowing arterials and expressway sections, and finally, STOP-sign controlled intersections.

The first step in the process is to assemble the data required regarding volume, vehicle type distribution, percent of vehicles operating in the cold mode, etc., and a site sketch showing street geometry and dimensions as well as the assumed receptor location. Worksheets No. 5 and 6 are then used to compute the likely maximum concentration based on the various data elements and the relationships presented in Tables 5 through 8, and the graphs shown in Figures 25 through 31. Worksheets No. 5 and 6 are each followed by detailed instructions for completing each line based on the various elements of traffic data, Figures 25 through 31, and Tables 5 through 8.

WORKSHEET NO. 5 1 of 3

CALCULATION OF CO CONCENTRATIONS AT INTERSECTIONS

Location: ________________________________ Date: ____________

Analysis by: ____________________________ Checked by: ____________

Assumptions:
- Analysis Year: __________.
- Location: (a) _____ California; (b) _____ 49-State, low altitude; (c) _____ 49-State, high altitude.
- Ambient temperature: ___°F.
- Percent of vehicles operating in: (a) cold-start mode _____; (b) hot-start mode _____.
- Vehicle-type distribution: LDV___%; LDT___%; HDV-G___%; HDV-D___%; MC___%.

	Main road		Crossroad	
1. Site identification				
2. a. i - intersection approach identification	1__	2__	3__	4__
b. Is approach located in a street canyon?				
3. n_i - Number of traffic lanes in approach i				
4. x_i - Roadway/receptor separation (m)			X	X
5. V_i - Peak-hour lane volume in each approach (veh/hr)				
6. S_i - Cruise speed (mph) on each approach				
7. a. Type of intersection (signalized or unsignalized)				
b. For signalized intersections:				
i) $(G/Cy)_1$ - Green time/signal cycle ratio for approach 1		X	X	X
ii) V_{cross} - Effective crossroad volume (veh/hr)	X	X		
8. Le - Queue length on approach 1 (m)		X	X	X

Main road Crossroad

9. Qf_i - Free-flow emission rate (g/m-sec)

10. $\frac{\chi u}{Q}\ \text{f,main}$ - Normalized concentration contribution from free-flow emissions on main roadway (10^{-3} m^{-1})

11. $\frac{\chi u}{Q}\ \text{f,cross}$ - Normalized concentration contribution from free-flow emission on crossroad (10^{-3} m^{-1})

12. Cdf_i - Distance correction factor, free-flow emissions

13. C_{Ef} - Emissions correction factor, free-flow emissions.

14. a. $\chi_{f,main}$ - Concentration contribution from free-flow emissions on main road (mg/m^3)

b. $\chi_{f,cross}$ - Concentration contribution from free-flow emissions on crossroad (mg/m^3)

15. χ_f - Total concentration from free-flow emissions (mg/m^3)

16. C_{Ee} - Emissions correction factor, excess emissions

17. Q_e - Excess emission rate (g/m-sec)

18. $\frac{\chi u}{Q}\ \text{e,i}$ - Normalized concentration contribution from excess emissions on approach i ($10^{-3}m^{-1}$)

19. Cde_i - Distance correction factor, excess emissions

20. $\chi_{e,i}$ - Concentration contribution from excess emissions on approach i (mg/m^3)

21. χ_e - Total contribution from excess emissions (mg/m^3)

22. $\chi_{E,1\text{-}hr}$ - 1-hour average concentration resulting from vehicle emissions (mg/m^3)

23. $\chi_{E,\ 8\text{-hr}}$ - 8-hour average CO concentration (mg/m^3) ____________________

24. $\chi_{B,8\text{-hr}}$ - 8-hour average background concentration (mg/m^3) ____________________

25. $\chi_{T,8\text{-hr}}$ - Total CO concentration, 8-hour average (mg/m^3) ____________________

26. $\chi_{T,8\text{-hr}}$ - Total CO concentration, 8-hour average (ppm) ____________________

WORKSHEET NO. 5

INSTRUCTIONS FOR COMPLETING EACH LINE

I. HEADING DATA

Location: Enter intersection street name

Date: Enter date of analysis.

Analysis by: Enter name of person performing analysis.

Checked by: Enter name of person checking the completed Worksheet.

Assumptions: Analysis year - enter calendar year reflected by the analysis.

Location - place an X on the appropriate line indicating the type of location being considered (low altitude is < 3500 ft).

Ambient Temperature - enter the assumed average winter temperature for the area being considered (either 20°F or 40°F).

Percent of Vehicles - enter the proportion of vehicles operating in the cold-start mode and the proportion in the hot-start mode (see Section IV.C.3).

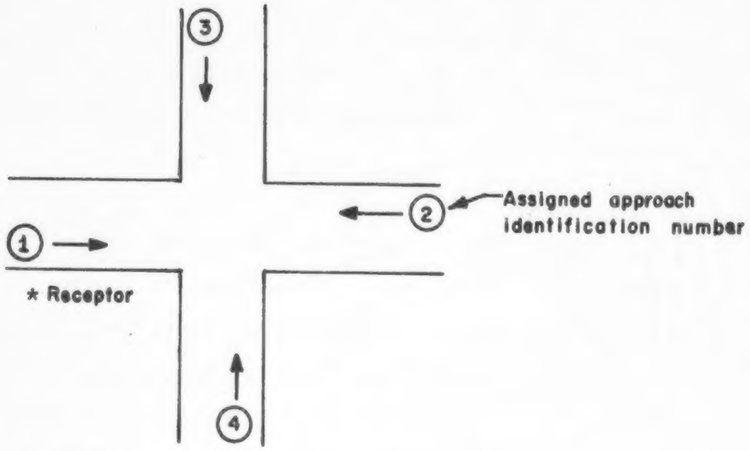
Vehicle-type distribution - enter the percentages of light-duty vehicles, light-duty trucks, heavy-duty gasoline-powered trucks, heavy-duty diesel-powered trucks, and motorcycles that use the streets being analyzed (use one set of percentages).

II. COMPUTATIONS

1. Enter the main street and cross-street names (refer to site sketch). The main street will always be the street adjacent to the receptor. In this connection, the assumed receptor location should be at the point where the maximum projected concentration is likely to occur. Guidance for identifying this point is provided in the Special Instructions found in Section IV.C beginning on page 113.

2. a. Intersection approach identification numbers should be added to the site sketch for reference. The designations should be made according to the sketch as shown.

   b. Enter "yes" or "no" for each approach. Guidance in identifying street canyons is provided in Section III beginning on page 57. If approach 1 is in a street canyon, then use the street canyon options indicated throughout the instructions that follow.



Note that approach ① is adjacent to the receptor, ② is on the leg opposite approach ①, ③ intersects ② before it intersects ①, and ④ intersects ① before it intersects ②. Again, refer to page 113.

3. Enter the number of lanes (omitting parking lanes) for each approach (from site sketch).

4. Enter the roadway/receptor separation distance, x_i, for approaches 1 and 2. This is the minimum perpendicular distance in meters from the centerline of the traffic stream approaching the intersection to a line parallel to the roadway drawn through the receptor site (see site sketch).

5. Enter the peak-hour lane volume, V_i (vehicles/hour), for each intersection approach. This is the total traffic stream volume divided by the number of approach lanes recorded on line 3. This should represent the busiest winter month* average weekday volume for the year of interest (based on traffic volume data).

6. Enter the estimated roadway cruise speed, S_i (mph), for each approach (see Section IV.C.2 on page 120 for guidance).

7. a. Enter type of intersection (signalized, unsignalized).

   b. For signalized intersections (for nonsignalized intersections proceed to next step):

      (i) Enter the ratio of green time to total signal cycle length $(G/Cy)_1$ allocated to approach 1. Include time allocated for any pedestrian walk phases with no traffic movement in the total cycle length. For fixed time signals, this data will be available from design specifications or from permits and records maintained by the agency having jurisdiction over the signal. For actuated signals, the G/Cy for approach i can be estimated from the equation:

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*This assumes that winter is the critical season for CO. If it is determined that some other season is in fact the critical season, then the corresponding traffic volumes and ambient temperature should be used.

$$G/Cy_i = \frac{0.9\ Vmax_i}{\sum_{i=1}^{n} V\ max}$$

where G/Cy_i is the G/Cy for approach i; and

Vmax is the highest hourly lane volume that occurs on all approaches where traffic moves during phase i.

(ii) Determine the effective crossroad volume, V_{cross}, for approach 1 using the following equation and the volume from line 5 if the signal is fixed time:

$$V_{cross} = \frac{\text{line } 5_1}{\text{line } 7.b.i + 0.05} - \text{line } 5_1$$

for actuated signals, V_{cross} = the highest volume in line 5_3 and 5_4.

8. Determine the queue length, Le (m), that develops on approach 1 as follows:

   For signalized intersections enter the appropriate section of Table 5 based on cruise speed S_1 (line 6). Enter the table using $V_{main} = V_1$ (line 5) and V_{cross} = line 7 b-ii.

   For unsignalized intersections use the appropriate section of Table 7 based on cruise speed S_1. Enter the table using $V_{main} = V_1$ (line 5) and $V_{cross} = V_3$ or V_4 (line 5), whichever is greater.

9. Enter the free-flow emission rate, Qf_i (g/m-sec), for each traffic stream using Table 6. Enter the table using line 6i (cruise speed) and line 5 (average lane volume) for each approach. If the street is within a street canyon, enter only the Qf_i for approaches 1 and 2.

10. Enter Figure 28 at the appropriate queue length, Le (line 8), and record the $(\chi u/Q)_f$ main value using the curve designated MAIN ROAD. If the location is within a street canyon, use Figure 29, using line 4_1 and 4_2.

11. Similarly, determine the normalized concentration contribution from free-flow emissions on the crossroad, $(\chi u/Q)_{f,cross}$. Use the CROSSROAD curve of Figure 28. Enter the graph at the same queue length as in step 10. Omit this step for street canyons.

12. Enter the distance correction factors, Cdf_i, for free-flow emissions from the main roadway. Obtain these values from Figure 31.

    a. Cdf_1 is the correction factor at $x = x_1$ (line 4).

    b. Cdf_2 is the correction factor for the departure lanes on leg 1, evaluated at x = the roadway/receptor separation distance for the departure stream. This value is x_2 (line $4)_2$.

Note: For street canyons, assume a value of 1.0.

13. Compute the free-flow emissions correction factor, C_{Ef}, reflecting the assumed calendar year, cruise speed, percentage of vehicles operating in the cold-start and hot-start modes, ambient temperature, and vehicle-type distribution. This is derived from the following equation:

$$C_{Ef} = P_{LDV}\, C_{LDV} + P_{LDT}\, C_{LDT} + P_{MC}\, C_{MC} + P_{HDG}\, C_{HDG} + P_{HDD}\, C_{HDD}$$

where P_{LDV} = fraction of light-duty vehicles (from heading data);

P_{LDT} = fraction of light-duty trucks (from heading data);

P_{MC} = fraction of motorcycles (from heading data);

P_{HDG} = fraction of heavy-duty, gasoline-powered trucks (from heading data);

P_{HDD} = fraction of heavy-duty, diesel-powered trucks (from heading data);

C_{LDV} = correction factor reflecting the assumed calendar year, cruise speed, percentage of vehicles operating in the cold start mode, percentage of vehicles operating in the hot-start mode, and ambient temperature for light-duty vehicles (obtained from Table 8);

C_{LDT} = correction factor reflecting the assured calendar year, cruise speed, percentage of vehicles operating in the cold-start mode, percentage of vehicles operating in the hot-start mode, and ambient temperature for light-duty trucks (obtained from Table 8);

C_{MC} = correction factor reflecting the assumed calendar year, cruise speed, percentage of vehicles operating in the cold-start mode, percentage of vehicles operating in the hot-start mode, and ambient temperature for motorcycles (obtained from Table 8);

C_{HDG} = correction factor reflecting the assumed calendar year and cruise speed for heavy-duty, gasoline-powered trucks (obtained from Table 8);

C_{HDD} = correction factor reflecting the assumed calendar year and cruise speed for heavy-duty, diesel-powered trucks (obtained from Table 8);

14. Compute the concentration contribution from free-flow emissions, χ_f, from each roadway

a. $$\chi_{f,main} = \Big[(\text{line } 10)(\text{line } 13)\Big] \Big[(\text{line } 3)_1 (\text{line } 9)_1 (\text{line } 12)_1 + (\text{line } 3)_2 (\text{line } 9)_2 (\text{line } 12)_2\Big]$$

b. $\chi_{f_{cross}} = \left[(\text{line } 11)(\text{line } 13)\right] \left[(\text{line } 3)_3(\text{line } 9)_3 + (\text{line } 3)_4 (\text{line } 9)_4\right]$

Note: for street canyons, $\chi_{f,cross}$, need not be computed.

15. Sum line 14a and 14b entries to obtain total contribution from free-flow emissions, χ_f.

16. Compute the excess emissions correction factor, C_{Ee}, reflecting the assumed calendar year, idle (speed 0), percentage of vehicles operating in the cold- or hot-start mode, ambient temperature, and vehicle type distribution. This is derived from the following equation:

$$C_{Ee} = P_{LDV}\, C_{LDV-0} + P_{LDT}\, C_{LDT-0} + P_{MC}\, C_{MC-0} + P_{HDG}\, C_{HDG-0} + P_{HDD}\, C_{HDD-0}$$

where P_{LDV}, P_{LDT}, P_{MC}, P_{HDG} and P_{HDD} are as defined in item 13, above; and

C_{LDV-0}, C_{LDT-0}, C_{MC-0}, C_{HDG-0}, and C_{HDD-0} are the correction factors from Table 12 reflecting the assumed calendar year, speed of 0, percentages of cold- and hot-start operation, and ambient temperature for each vehicle type.

17. Compute the excess emission rate, Q_e (g/m-sec), from:

$$Q_e = (Q_{QT})\,(C_{Ee}) - (Q_{QC})\,(C_{Ef})$$

where Q_{QT} = the total queue emission rate found in Table 5 for signalized intersections or Table 7 for nonsignalized intersection;

Q_{QC} = the cruise component of the queue emissions, also found in Table 5 for signalized intersections and Table 7 for nonsignalized intersections;

C_{Ee} = the excess emissions correction factor found in item 16, above; and

C_{Ef} = the free-flow emissions correction factor found in item 13, above.

To use Tables 5 or 7, the highest main road lane volume from line 5 and the effective crossroad volume, V_{CROSS}, from line 7.6.ii are used. Interpolation should be performed as required in using the tables.

18. Determine the normalized concentration contribution from excess emissions, $(\chi u/Q)_{e,i}$ for each approach as follows:

a. The contribution from approach 1:
Enter Figure 25 at the appropriate queue length, Le (line 8), to obtain $(\chi u/Q)_{e,i}$. Multiply this value by the number of traffic lanes in approach 1 (line 3), and record result. For street canyons, the procedure is the same except use Figure 29 instead of 25.

b. The contribution from approach:
Enter Figure 26, curve 2, at the same Le, used in part (a), (line 8), to obtain $(\chi u/Q)_{e,2}$. Multiply this value by the number of traffic lanes in approach 2 (line 3), and record result. For street canyons, assume $(\chi u/Q)_{e,2} = 0$.

c. The contribution from approach 3:
Signalized intersections - Enter Figure 26, Curve 3 at Le (line 8) to obtain $(\chi u/Q)_{e,3}$. Multiply by the number of traffic lanes in approach 3 (line 3), and record result. For street canyons and unsignalized intersections, $(\chi u/Q)_{e,3} = 0$.

d. The contribution from approach 4:
Signalized intersections - Enter Figure 26. Curve 4 at Le (line 8) to obtain $(\chi u/Q)_{e,4}$. Multiply by the number of traffic lanes in approach 4 (line 3) and record result. For street canyons and unsignalized intersections, $(\chi u/Q)_{e,4} = 0$.

19. Determine the distance correction factors for the excess emissions contributions, Cde_i:

a. Approach 1: obtain Cde_1 from Figure 30 at the appropriate roadway/receptor separation distance x_1 (line 4).
Note: For street canyons, $Cde_1 = 1.0$.

b. Approach 2: compute Cde_2 by dividing the value obtained from Figure 30 at the appropriate distance x_2 (line 4) by 0.79:

$$Cde_2 = \frac{Cde \text{ (at } x_2)}{0.79}$$

c. Approach 3&4:$Cde_{3,4}$= 1 for signalized intersections and $Cde_{3,4}$= 0 for nonsignalized intersections.

20. Compute the concentration contribution from excess emissions, χ_e, for each approach i, using the following equation:

$$\chi_{ei} = (Q_E)\left(\frac{\chi u}{Q}\right)_{ei}(Cde)_i$$

where Q_E = the excess emission rate from line 17;

$\left(\frac{\chi u}{Q}\right)_{ei}$ = the normalized concentration contribution from excess emissions from line 18; and

$\left(Cde\right)_i$ = the distance correction from line 19.

21. Sum all line 20 entries to obtain the total concentration, χ_e, resulting from excess emissions at the intersection.

22. Compute the 1-hour average concentration resulting from vehicle emissions, $\chi_{E,\ 1\text{-hour}}$, by summing line 21 and line 15.

23. Multiply line 22 by 0.7 to obtain the highest expected 8-hour average concentration resulting from vehicle emissions.

24. Enter 8-hour average background CO concentration in mg/m^3. Use 2.9 mg/m^3 if specific local background estimates are not available and see Section V.B. of Volume I.

25. Sum lines 23 and 24 to obtain maximum expected 8-hour average concentration in the vicinity of the intersection (mg/m^3).

26. Multiply line 25 by 0.87 to convert the CO concentration from mg/m^3 to ppm.

WORKSHEET NO. 6

CALCULATION OF CO CONCENTRATIONS ALONG ROADWAYS WHERE UNINTERRUPTED FLOW PREVAILS

Location: ______________________________ Date: __________

Analysis by: __________________________ Checked by: __________

Assumptions:
- Analysis Year: ________.
- Location: (a)_______ California; (b) _____49-State, low altitude; (c)_____49-State, high altitude.
- Ambient temperature: ______°F.
- Percent of vehicles operating in: (a) cold-start mode_____%; (b) hot-start mode_______%.
- Vehicle-type distribution: LDV ____%, LDT ____%; HDV-G____%; HDV-D____; MC____%.
- Street Canyon: _____ Yes; _____ No.

1. Site identification		
2. Traffic stream identification	1 ___	2 ___
3. V_i - Peak-hour lane volume for each traffic stream (veh/hr)		
4. x_i - Roadway/receptor separation (m)		
5. n_i - Number of lanes per traffic stream		
6. S_i - Cruise speed (mph) for each traffic stream		
7. Q_{fi} - Free-flow emission rate (g/m-sec)		
8. $\left(\frac{\chi u}{Q}\right)_{f,i}$ - Normalized concentration contribution from each traffic stream (10^{-3} m^{-1})		
9. C_{Ef} - Emission correction factor		
10. χ_i - Concentration contribution from each traffic stream (mg/m^3)		

Worksheet No. 6 (continued).

11. X_E, 1-hr - 1-hour average CO concentration resulting from vehicle emissions (mg/m^3) ________________

12. X_E, 8-hr - 8-hour average CO concentration (mg/m^3) ________________

13. X_B, 8-hr - 8-hour average background concentration (mg/m^3) ________________

14. X_T, 8-hr - Total CO concentration, 8-hour average (mg/m^3) ________________

15. X_T, 8-hr - Total CO concentration, 8-hour average (ppm) ________________

WORKSHEET NO. 6

INSTRUCTIONS FOR COMPLETING EACH LINE

I. HEADING DATA

Location: Enter facility name and general location (e.g., Mystic Parkway between exits 60 and 61).

Date: Enter date of analysis.

Analysis by: Enter name of person performing analysis.

Checked by: Enter name of person checking the completed Worksheet

Assumptions: Analysis year - enter calendar year reflected by the analysis.

Location - place an X on the appropriate line indicating the type of location being considered (low altitude is < 3500 ft).

Ambient Temperature - enter the assumed average winter temperature for the area being considered (either 20°F or 40°F).

Percent of Vehicles - enter the proportion of vehicles operating in the cold-start mode and the proportion in the hot-start mode.

Vehicle-type distribution - enter the percentages of light-duty vehicles, light-duty trucks heavy-duty gasoline-powered trucks, heavy-duty diesel-powered trucks, and motorcycles that use the streets being analyzed (use one set of percentages).

Street Canyon: place an X on the appropriate line (see the previous section for guidance in identifying street canyons).

II. COMPUTATIONS

1. Enter the facility name.

2. Enter the direction of flow for each traffic stream (e.g., northbound, eastbound, etc.). Again, approach 1 shall be adjacent to the assumed receptor.

3. Enter the peak-hour traffic volume, V_i, for each traffic stream (winter, busiest month, estimates or observed).

4. Enter the traffic stream/receptor separation distance, x_i. This is the perpendicular distance in meters from the centerline of each traffic stream to the receptor location. Minimum distance = 10 meters.

5. Enter the number of lanes, n_i, per traffic stream (see site sketch).

6. Enter the average cruise speed, S_i (mph), for each traffic stream (for guidance, see Section IV.C.).

7. Determine the free-flow emission rate, Qf_i (g/m-sec), for each traffic stream from Table 3. Enter the table using line 6, cruise speed and (line 3) ÷ (line 5), average lane volumes.

8. Determine the normalized concentration contribution $(\chi u/Q)f, i$ from each traffic stream using Figure 27. Enter the graph at the appropriate roadway/receptor separation distance x_i (line 4). If the facility is located within a street canyon, use Figure 29.

9. Compute the free-flow emissions correction factor, C_{Ef}, reflecting the assumed calendar year, cruise speed, percentage of vehicles operating in the cold-start mode, percentage of vehicles operating in the hot-start start mode, ambient temperature, and vehicle-type distribution; C_{Ef} is derived using the equation shown in Item 13 of the instruction sheet explaining Worksheet No. 5.

10. Compute the concentration contribution, χ_i, from each stream as follows:

    $$\chi_i = (\text{line } 7)_i \, (\text{line } 8)_i \, (\text{line } 9)$$

11. Compute the 1-hour average CO concentration resulting from vehicle emissions by summing the line 10 concentrations.

12. Multiply line 11 by 0.7 to obtain the highest expected 8-hour average concentration resulting from vehicle emissions (mg/m^3).

13. Enter the 8-hour average background CO concentration in mg/m^3. Use the 2.9 mg/m^3 if specific local background estimates are not available.

14. Sum line 15 and line 16 to obtain the maximum expected 8-hour average concentration in the vicinity of the roadway (mg/m^3).

15. Multiply line 17 by 0.87 to convert total CO concentration to ppm.

Table 5. TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 15 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	–	–	0.04181	0.01912	–	–	–	–	–	–	–	–	–	–
	Q_{QC}	–	–	0.00013	–	–	–	–	–	–	–	–	–	–	–
	Queue	–	–	796.5	–	–	–	–	–	–	–	–	–	–	–
1300	Q_{QT}	–	0.05141	0.04023	0.03504	0.01828	–	–	–	–	–	–	–	–	–
	Q_{QC}	–	0.00004	0.00030	0.00020	–	–	–	–	–	–	–	–	–	–
	Queue	–	1901.4	347.2	670.4	–	–	–	–	–	–	–	–	–	–
1200	Q_{QT}	–	0.04837	0.03873	0.03615	0.03051	0.01609	–	–	–	–	–	–	–	–
	Q_{QC}	–	0.00019	0.00050	0.00043	0.00024	–	–	–	–	–	–	–	–	–
	Queue	–	367.9	205.7	314.7	698.6	–	–	–	–	–	–	–	–	–
1100	Q_{QT}	–	0.04542	0.3732	0.03331	0.03029	0.02765	0.01531	–	–	–	–	–	–	–
	Q_{QC}	–	0.00039	0.00073	0.00068	0.00050	0.00027	–	–	–	–	–	–	–	–
	Queue	–	173.2	139.0	197.4	333.4	757.5	–	–	–	–	–	–	–	–
1000	Q_{QT}	–	0.04262	0.03601	0.03253	0.02980	0.02736	0.02504	0.01306	–	–	–	–	–	–
	Q_{QC}	–	0.00065	0.00099	0.00094	0.00077	0.00055	0.00028	–	–	–	–	–	–	–
	Queue	–	103.9	101.2	139.4	211.9	362.9	826.6	–	–	–	–	–	–	–
900	Q_{QT}	–	0.04005	0.03481	0.03181	0.02933	0.02706	0.02488	0.02274	–	–	–	–	–	–
	Q_{QC}	–	0.00096	0.00127	0.00123	0.00106	0.00083	0.00058	0.00030	–	–	–	–	–	–
	Queue	–	70.2	77.3	105.0	151.1	231.0	395.2	899.1	–	–	–	–	–	–
800	Q_{QT}	–	0.03775	0.03373	0.03114	0.02888	0.02676	0.02470	0.02268	0.02065	0.01003	–	–	–	–
	Q_{QC}	–	0.00130	0.00158	0.00153	0.00136	0.00113	0.00087	0.00060	0.00030	–	–	–	–	–
	Queue	–	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	–	–	–	–	–

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 15 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.03470	0.03278	0.03051	0.02842	0.02643	0.02449	0.02258	0.02066	0.01870	0.00852	-	-	-
	Q_{QC}	-	0.00163	0.00191	0.00184	0.00166	0.00143	0.00118	0.00090	0.00061	0.00031	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.04534	0.02602	0.03192	0.02988	0.02793	0.02605	0.02423	0.02243	0.02062	0.01878	0.01686	0.00789	-	-
	Q_{QC}	0.00051	0.00159	0.00226	0.00217	0.00198	0.00174	0.00148	0.00121	0.00092	0.00062	0.00032	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.02441	0.02006	0.02561	0.02921	0.02736	0.02559	0.02388	0.02220	0.02051	0.01880	0.01701	0.01512	0.00694	-
	Q_{QC}	0.00084	0.00154	0.00216	0.00250	0.00230	0.00205	0.00179	0.00151	0.00123	0.00093	0.00363	0.00032	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.9	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.01302	0.01568	0.02038	0.02540	0.02665	0.02499	0.02341	0.02186	0.02033	0.01876	0.01712	0.01538	0.01347	0.00492
	Q_{QC}	0.00082	0.00146	0.00202	0.00253	0.00261	0.00236	0.00209	0.00181	0.00153	0.00124	0.00094	0.00064	0.00032	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.00851	0.01216	0.01579	0.01948	0.02351	0.02418	0.02276	0.02139	0.02004	0.01867	0.01722	0.01566	0.01393	0.01196
	Q_{QC}	0.00078	0.00134	0.00182	0.00225	0.00267	0.00265	0.00238	0.00210	0.00181	0.00153	0.00124	0.00094	0.00064	0.00032
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.00601	0.00893	0.01142	0.01392	0.01666	0.01984	0.02187	0.02077	0.01968	0.01857	0.01739	0.01608	0.01460	0.01284
	Q_{QC}	0.00071	0.00117	0.00153	0.00186	0.00218	0.00250	0.00262	0.00234	0.00206	0.00178	0.00150	0.00122	0.00093	0.00063
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00384	0.00544	0.00686	0.00838	0.01012	0.01217	0.01464	0.01768	0.01937	0.01870	0.01795	0.01708	0.01601	0.01465
	Q_{QC}	0.00056	0.00086	0.00109	0.00130	0.00151	0.00172	0.00195	0.00219	0.00221	0.00194	0.00168	0.00141	0.00115	0.00088
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 20 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04199	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00016	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05146	0.4065	0.03532	0.1812	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00004	0.00036	0.00025	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	367.2	670.4	-	-	-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.04863	0.03963	0.03475	0.03116	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00023	0.00061	0.00053	0.00030	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.04598	0.03834	0.03426	0.03100	0.02803	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00049	0.00089	0.00083	0.00062	0.00033	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.4	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.04354	0.03739	0.03386	0.03089	0.02812	0.02544	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00081	0.00121	0.00116	0.00095	0.00067	0.00035	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.04139	0.03660	0.03354	0.03082	0.02823	0.02569	0.02316	-	-	-	-	-	-
	Q_{QC}	-	0.00118	0.00157	0.00151	0.00130	0.00103	0.00071	0.00036	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.03959	0.03596	0.03329	0.03078	0.02834	0.02593	0.02352	0.02108	0.01003	-	-	-	-
	Q_{QC}	-	0.00161	0.00195	0.00188	0.00167	0.00139	0.00108	0.00073	0.00038	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street efective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 20 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.03699	0.03547	0.03309	0.03075	0.02844	0.02615	0.02385	0.02152	0.01914	0.00852	-	-	-
	Q_{QC}	-	0.00201	0.00236	0.00227	0.00205	0.00177	0.00145	0.00111	0.00075	0.00038	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.04606	0.02826	0.03510	0.03292	0.03070	0.02850	0.02631	0.02412	0.02191	0.01965	0.01730	0.00789	-	-
	Q_{QC}	0.00063	0.00196	0.00279	0.00267	0.00243	0.00215	0.00183	0.00149	0.00113	0.00077	0.00039	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.02559	0.02222	0.02864	0.03272	0.03058	0.02847	0.02639	0.02432	0.02224	0.02011	0.01790	0.10557	0.00694	-
	Q_{QC}	0.00103	0.00189	0.00266	0.00308	0.00283	0.00253	0.00220	0.00186	0.00151	0.00115	0.00078	0.00039	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.0	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.01416	0.01773	0.02322	0.02896	0.03032	0.02830	0.02634	0.02441	0.02247	0.02050	0.01844	0.01627	0.01393	0.0492
	Q_{QC}	0.00100	0.00180	0.00248	0.00312	0.00321	0.00290	0.00257	0.00223	0.00188	0.00152	0.00116	0.00078	0.00040	-
	Queue	40.4	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.00960	0.01404	0.01835	0.02264	0.02726	0.02790	0.02609	0.02434	0.02259	0.02081	0.01896	0.01698	0.01483	0.01242
	Q_{QC}	0.00096	0.00166	0.00224	0.00277	0.00328	0.00326	0.00292	0.00238	0.00223	0.00188	0.00152	0.00116	0.00078	0.00040
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.00701	0.01056	0.01357	0.01653	0.01972	0.02335	0.02555	0.02405	0.02258	0.02107	0.01949	0.01779	0.01590	0.01373
	Q_{QC}	0.00087	0.00143	0.00189	0.00229	0.00268	0.00308	0.00323	0.00288	0.00254	0.00219	0.00184	0.00150	0.00114	0.00078
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00463	0.00664	0.00839	0.01021	0.01224	0.01459	0.01738	0.02075	0.02247	0.02143	0.02031	0.01906	0.01762	0.01589
	Q_{QC}	0.00069	0.00105	0.00134	0.00160	0.00186	0.00212	0.00240	0.00269	0.00271	0.00239	0.00206	0.00174	0.00142	0.00109
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 25 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04220	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00019	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05152	0.04112	0.03565	0.01828	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00095	0.00043	0.00030	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	347.2	670.4	-	-	-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.04894	0.04023	0.03545	0.03155	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00027	0.00072	0.00063	0.00036	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.04662	0.03951	0.03536	0.03181	0.02866	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00058	0.00106	0.00099	0.00073	0.00039	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.4	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.04460	0.03899	0.03539	0.03214	0.02901	0.02590	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00096	0.00144	0.00138	0.00113	0.00080	0.00042	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.04294	0.03866	0.03552	0.03254	0.02958	0.02662	0.02364	-	-	-	-	-	-
	Q_{QC}	-	0.00140	0.00186	0.00180	0.00155	0.00122	0.00084	0.00043	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.04170	0.03852	0.03576	0.03298	0.03017	0.02734	0.02448	0.02157	0.01003	-	-	-	-
	Q_{QC}	-	0.00191	0.00232	0.00224	0.00198	0.00165	0.00128	0.00087	0.00045	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 25 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.03963	0.03856	0.03607	0.03344	0.03076	0.02805	0.02530	0.02251	0.01964	0.00852	-	-	-
	Q_{QC}	-	0.00239	0.00280	0.00269	0.00243	0.00210	0.00172	0.00132	0.00090	0.00046	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.04688	0.03084	0.03876	0.03642	0.03390	0.03132	0.02871	0.02608	0.02340	0.02066	0.01782	0.00789	-	-
	Q_{QC}	0.00075	0.00233	0.00331	0.00317	0.00289	0.00255	0.00217	0.00177	0.00135	0.00091	0.00046	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.02694	0.02471	0.03214	0.03676	0.03429	0.03179	0.02928	0.02677	0.02422	0.02162	0.01892	0.01609	0.00694	-
	Q_{QC}	0.00123	0.00225	0.00316	0.00366	0.00336	0.00300	0.00262	0.00221	0.00180	0.00137	0.00092	0.00047	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.9	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.01548	0.02009	0.02648	0.03305	0.03454	0.03212	0.02972	0.02734	0.02494	0.02250	0.01996	0.01730	0.01445	0.00492
	Q_{QC}	0.00119	0.00214	0.00295	0.00371	0.00382	0.00345	0.00306	0.00265	0.00223	0.00181	0.00138	0.00093	0.00047	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.01085	0.01622	0.02129	0.02628	0.03157	0.03218	0.02993	0.02773	0.02552	0.02328	0.02095	0.01850	0.01585	0.01294
	Q_{QC}	0.00114	0.00197	0.00266	0.00329	0.00390	0.00388	0.00347	0.00307	0.00265	0.00223	0.00181	0.00137	0.00093	0.00048
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.00815	0.01245	0.01604	0.01954	0.02324	0.02739	0.02978	0.02783	0.02590	0.02395	0.02192	0.01975	0.01740	0.01475
	Q_{QC}	0.00103	0.00170	0.00224	0.00272	0.00319	0.00365	0.00383	0.00342	0.00301	0.00260	0.00219	0.00178	0.00136	0.00092
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00553	0.00803	0.01015	0.01231	0.01468	0.01738	0.02052	0.02428	0.02604	0.02456	0.02302	0.02135	0.01948	0.01731
	Q_{QC}	0.00082	0.00125	0.00159	0.00191	0.00221	0.00252	0.00285	0.00320	0.00323	0.00284	0.00245	0.00207	0.00168	0.00129
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 30 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04244	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00022	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05159	0.04168	0.03604	0.01828	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00006	0.00051	0.00035	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	347.2	670.4	-	-	-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.04929	0.04117	0.03626	0.02101	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00032	0.00086	0.00074	0.00042	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.04737	0.04090	0.03665	0.03277	0.02897	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00068	0.00125	0.00117	0.00087	0.00046	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.4	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.04585	0.04086	0.03718	0.03362	0.03004	0.02644	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00113	0.00170	0.00163	0.00134	0.00094	0.00049	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.0447	0.04108	0.03786	0.03455	0.03117	0.02772	0.02420	-	-	-	-	-	-
	Q_{QC}	-	0.00166	0.00220	0.00212	0.00183	0.00144	0.00099	0.00051	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.04418	0.04153	0.03867	0.03556	0.03232	0.02901	0.02562	0.02215	0.01003	-	-	-	-
	Q_{QC}	-	0.00225	0.00273	0.00264	0.00236	0.00195	0.00151	0.00103	0.00053	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 30 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.04273	0.04221	0.03958	0.03661	0.03349	0.03029	0.02702	0.02367	0.02023	0.00852	-	-	-
	Q_{QC}	-	0.00282	0.00331	0.00318	0.00287	0.00248	0.00203	0.00156	0.00106	0.00054	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.04785	0.03387	0.04307	0.04055	0.03766	0.03463	0.03153	0.02837	0.02515	0.02185	0.01842	0.00789	-	-
	Q_{QC}	0.00088	0.00275	0.00391	0.000374	0.00342	0.00301	0.00256	0.00209	0.00159	0.00108	0.00055	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.02854	0.02763	0.03625	0.04152	0.03866	0.03569	0.03269	0.03976	0.02656	0.02339	0.02012	0.01670	0.00694	-
	Q_{QC}	0.00145	0.00266	0.00373	0.00432	0.00396	0.00355	0.00309	0.00261	0.00212	0.00161	0.00109	0.00055	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.5	137.9	195.0	296.7	504.4	1164.9	-	-
400	Q_{QT}	0.01703	0.02287	0.03032	0.03787	0.03951	0.03660	0.03370	0.03079	0.02785	0.02485	0.02175	0.01851	0.01507	0.00492
	Q_{QC}	0.00161	0.00252	0.00349	0.00438	0.00451	0.00407	0.00361	0.00313	0.00264	0.00214	0.00162	0.00110	0.00045	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1108.2	-
300	Q_{QT}	0.01233	0.01878	0.02475	0.03056	0.03664	0.03722	0.03445	0.03171	0.02897	0.02618	0.02330	0.01019	0.01707	0.01356
	Q_{QC}	0.00134	0.00232	0.00316	0.00389	0.00461	0.00458	0.00410	0.00362	0.00313	0.00264	0.00213	0.00162	0.00110	0.00056
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.00949	0.01466	0.01896	0.02308	0.02738	0.03214	0.03477	0.03229	0.02982	0.02733	0.02477	0.02207	0.01916	0.01595
	Q_{QC}	0.00122	0.00201	0.00265	0.00321	0.00376	0.00431	0.00453	0.00404	0.00356	0.00307	0.00259	0.00210	0.00160	0.00109
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00660	0.00965	0.01222	0.01479	0.01756	0.02066	0.02423	0.02844	0.03023	0.02825	0.02621	0.02404	0.02167	0.01899
	Q_{QC}	0.00097	0.00148	0.00188	0.00225	0.00261	0.00298	0.00336	0.00378	0.00381	0.00335	0.00290	0.00244	0.00199	0.00152
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 35 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04273	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00027	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05167	0.04235	0.03650	0.01828	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00007	0.00061	0.00042	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	347.2	670.4	-		-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.04971	0.04229	0.03724	0.03256	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00038	0.00102	0.00088	0.00050	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.04826	0.04254	0.03818	0.03390	0.02958	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00081	0.00149	0.00139	0.00103	0.00055	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.4	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.04733	0.04310	0.03932	0.03537	0.03128	0.027080	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00134	0.00203	0.00194	0.00159	0.00112	0.00058	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.04694	0.04396	0.04064	0.03695	0.03306	0.02902	0.02487	-	-	-	-	-	-
	Q_{QC}	-	0.00197	0.00262	0.00252	0.00218	0.00171	0.00118	0.00061	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.04713	0.04511	0.04212	0.03863	0.03488	0.03098	0.02697	0.02284	0.01003	-	-	-	-
	Q_{QC}	-	0.00268	0.00325	0.00314	0.00279	0.00232	0.00180	0.00123	0.00063	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	116.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 35 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.04643	0.04654	0.04374	0.04037	0.03674	0.03295	0.02906	0.02506	0.02094	0.00852	-	-	-
	Q_{QC}	-	0.00336	0.00394	0.00379	0.00342	0.00295	0.00242	0.00185	0.00126	0.00064	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.04901	0.03747	0.04819	0.04545	0.04214	0.03857	0.03489	0.03111	0.02724	0.02326	0.01914	0.00789	-	-
	Q_{QC}	0.00105	0.00327	0.00465	0.00446	0.00406	0.00358	0.00305	0.00248	0.00189	0.00128	0.00065	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.03044	0.00111	0.04114	0.04718	0.04385	0.04034	0.03674	0.03307	0.02933	0.02551	0.02155	0.01742	0.00694	-
	Q_{QC}	0.00172	0.00316	0.00444	0.00514	0.00472	0.00422	0.00368	0.00311	0.00252	0.00192	0.00130	0.00066	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.9	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.01888	0.02617	0.03488	0.04361	0.04542	0.04194	0.03843	0.03489	0.03130	0.02765	0.02388	0.01995	0.01580	0.00492
	Q_{QC}	0.00168	0.00300	0.00615	0.00521	0.00537	0.00485	0.00430	0.00373	0.00314	0.00254	0.00193	0.00131	0.00066	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.01408	0.02182	0.02887	0.03565	0.04267	0.04322	0.03983	0.03645	0.03307	0.02963	0.02610	0.02241	0.01851	0.01430
	Q_{QC}	0.00160	0.00276	0.00374	0.00463	0.00548	0.00545	0.00488	0.00431	0.00372	0.00314	0.00254	0.00193	0.0013	0.00067
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.01109	0.01730	0.02242	0.02729	0.03231	0.03779	0.04070	0.03758	0.03448	0.03136	0.02816	0.02482	0.02126	0.01738
	Q_{QC}	0.00145	0.00239	0.00315	0.00382	0.00448	0.00513	0.00539	0.00481	0.00423	0.00366	0.00308	0.00250	0.00190	0.00130
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00787	0.01159	0.01469	0.01774	0.02098	0.02456	0.02863	0.03339	0.03522	0.03264	0.03000	0.02724	0.02428	0.02099
	Q_{QC}	0.00115	0.00176	0.00224	0.00268	0.00311	0.00354	0.00400	0.00449	0.00453	0.00399	0.00345	0.00291	0.00236	0.00181
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 40 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04308	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00032	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05177	0.04315	0.03705	0.01828	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00009	0.000073	0.00051	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	347.2	670.4	-	-	-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.05022	0.04362	0.03840	0.03322	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00046	0.00123	0.00107	0.00060	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.04932	0.04450	0.04001	0.03525	0.03030	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00098	0.00180	0.00168	0.00124	0.00066	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.6	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.04909	0.04576	0.04186	0.03746	0.03275	0.02785	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00162	0.00245	0.00234	0.00192	0.00135	0.00070	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.04953	0.04739	0.04395	0.03981	0.03530	0.03057	0.02567	-	-	-	-	-	-
	Q_{QC}	-	0.00238	0.00316	0.00304	0.00263	0.00207	0.00143	0.00073	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.05065	0.04938	0.04625	0.04229	0.03793	0.03334	0.02858	0.02366	0.01003	-	-	-	-
	Q_{QC}	-	0.00323	0.00393	0.00379	0.00336	0.00280	0.00217	0.00148	0.00076	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 40 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.05083	0.05170	0.04871	0.04486	0.04060	0.03613	0.03149	0.02671	0.02178	0.00852	-	-	-
	Q_{QC}	-	0.00405	0.00475	0.00457	0.00412	0.00356	0.00292	0.00223	0.00152	0.00077	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	177.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.05039	0.04177	0.05430	0.05130	0.04747	0.04327	0.03889	0.03436	0.02972	0.02494	0.01999	0.00789	-	-
	Q_{QC}	0.00127	0.00395	0.00561	0.00537	0.00490	0.00432	0.00368	0.00299	0.00228	0.00155	0.00079	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.03270	0.03526	0.04697	0.05392	0.05004	0.04587	0.04156	0.03715	0.03264	0.02802	0.02325	0.01829	0.00694	-
	Q_{QC}	0.00208	0.00381	0.00536	0.00620	0.00569	0.00509	0.00444	0.00375	0.00304	0.00231	0.00157	0.00079	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.9	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.02107	0.03011	0.04032	0.05049	0.05246	0.04830	0.04406	0.03977	0.03542	0.03098	0.02641	0.02166	0.01667	0.00492
	Q_{QC}	0.00202	0.00362	0.00500	0.00628	0.00647	0.00585	0.00518	0.00449	0.00379	0.00307	0.00233	0.00158	0.00080	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.01618	0.02544	0.03377	0.04172	0.04986	0.05037	0.04623	0.04211	0.03796	0.03375	0.02943	0.02494	0.02023	0.01517
	Q_{QC}	0.00192	0.00333	0.00451	0.00558	0.00661	0.00657	0.00589	0.00519	0.00449	0.00378	0.00306	0.00233	0.00158	0.00081
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.01300	0.02044	0.02655	0.03231	0.03819	0.04453	0.04776	0.04389	0.04004	0.03616	0.03220	0.02809	0.02375	0.01908
	Q_{QC}	0.00175	0.00289	0.00380	0.00461	0.00540	0.00619	0.00650	0.00580	0.00411	0.00441	0.00372	0.00301	0.00230	0.00156
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.00939	0.01390	0.01762	0.02125	0.02506	0.02921	0.03388	0.03928	0.04117	0.03788	0.03453	0.03106	0.02738	0.02337
	Q_{QC}	0.00139	0.00212	0.00270	0.00323	0.00375	0.00427	0.00483	0.00542	0.00547	0.00481	0.00416	0.00351	0.00285	0.00219
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 45 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	-	-	0.04350	0.01912	-	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	-	0.00039	-	-	-	-	-	-	-	-	-	-	-
	Queue	-	-	796.5	-	-	-	-	-	-	-	-	-	-	-
1300	Q_{QT}	-	0.05189	0.04410	0.03771	0.01828	-	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00011	0.00089	0.00062	-	-	-	-	-	-	-	-	-	-
	Queue	-	1901.4	347.2	670.4	-	-	-	-	-	-	-	-	-	-
1200	Q_{QT}	-	0.05081	0.04521	0.03978	0.03600	0.01609	-	-	-	-	-	-	-	-
	Q_{QC}	-	0.00057	0.00150	0.00130	0.00074	-	-	-	-	-	-	-	-	-
	Queue	-	367.9	205.7	314.7	698.6	-	-	-	-	-	-	-	-	-
1100	Q_{QT}	-	0.05059	0.04683	0.04218	0.03686	0.03116	0.01531	-	-	-	-	-	-	-
	Q_{QC}	-	0.00120	0.00220	0.00205	0.00152	0.00081	-	-	-	-	-	-	-	-
	Queue	-	173.2	139.0	197.4	333.4	757.5	-	-	-	-	-	-	-	-
1000	Q_{QT}	-	0.05119	0.04892	0.04489	0.03996	0.03450	0.02876	0.01306	-	-	-	-	-	-
	Q_{QC}	-	0.00198	0.00299	0.00286	0.00235	0.00165	0.00086	-	-	-	-	-	-	-
	Queue	-	103.9	101.2	139.4	211.9	362.9	826.6	-	-	-	-	-	-	-
900	Q_{QT}	-	0.05260	0.05147	0.04789	0.04321	0.03798	0.03242	0.02662	-	-	-	-	-	-
	Q_{QC}	-	0.00291	0.00386	0.00372	0.00321	0.00253	0.00174	0.00090	-	-	-	-	-	-
	Queue	-	70.2	77.3	105.0	151.1	231.0	395.2	899.1	-	-	-	-	-	-
800	Q_{QT}	-	0.05483	0.05466	0.05114	0.04664	0.04156	0.03614	0.03069	0.02464	0.01003	-	-	-	-
	Q_{QC}	-	0.00395	0.00480	0.00463	0.00411	0.00343	0.00265	0.00181	0.00092	-	-	-	-	-
	Queue	-	51.0	60.9	82.3	114.5	164.5	250.5	427.4	971.8	-	-	-	-	-

Table 5 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - SIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume - (assumed cruise speed is 45 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	-	0.05607	0.05784	0.05462	0.05019	0.04520	0.03990	0.03438	0.02867	0.02278	0.00852	-	-	-
	Q_{QC}	-	0.00495	0.00580	0.00558	0.00504	0.00436	0.00357	0.00273	0.00185	0.00094	-	-	-	-
	Queue	-	40.0	49.1	66.0	89.8	124.2	117.2	268.6	457.6	1042.1	-	-	-	-
600	Q_{QT}	0.05203	0.04687	0.06155	0.05825	0.05380	0.04886	0.04364	0.03824	0.03267	0.02694	0.02101	0.00789	-	-
	Q_{QC}	0.00155	0.00483	0.00686	0.00657	0.00599	0.00528	0.00449	0.00366	0.00279	0.00189	0.00096	-	-	-
	Queue	66.8	40.0	40.1	53.8	71.9	96.6	132.4	187.8	283.9	484.0	1107.7	-	-	-
500	Q_{QT}	0.03539	0.04019	0.05390	0.06194	0.05740	0.05245	0.04730	0.04200	0.03658	0.03101	0.02527	0.01931	0.00694	-
	Q_{QC}	0.00234	0.00466	0.00655	0.00758	0.00695	0.00622	0.00542	0.00458	0.00372	0.00283	0.00191	0.00097	-	-
	Queue	40.0	40.0	40.0	44.0	58.0	76.3	101.4	137.9	195.0	294.7	504.4	1164.9	-	-
400	Q_{QT}	0.02369	0.03479	0.04679	0.05857	0.06083	0.05586	0.05076	0.04558	0.04032	0.03495	0.02943	0.02370	0.01771	0.00492
	Q_{QC}	0.00247	0.00442	0.00611	0.00768	0.00791	0.00714	0.00633	0.00549	0.00463	0.00375	0.00285	0.00193	0.00098	-
	Queue	40.0	40.0	40.0	40.0	46.5	60.2	78.2	103.1	139.5	197.1	298.8	515.5	1208.3	-
300	Q_{QT}	0.01866	0.02975	0.03960	0.04893	0.05841	0.05886	0.05384	0.04882	0.04376	0.03864	0.03339	0.02796	0.02227	0.01622
	Q_{QC}	0.00235	0.00407	0.00551	0.00682	0.00808	0.00803	0.00719	0.00635	0.00549	0.00462	0.00374	0.00285	0.00193	0.00098
	Queue	40.0	40.0	40.0	40.0	40.0	46.6	59.4	76.5	100.4	135.6	191.8	292.6	511.1	1226.4
200	Q_{QT}	0.01526	0.02417	0.03146	0.03827	0.04516	0.05254	0.05616	0.05139	0.04664	0.04187	0.03700	0.03199	0.02673	0.02110
	Q_{QC}	0.00214	0.00353	0.00464	0.00564	0.00660	0.00757	0.00794	0.00709	0.00624	0.00539	0.00454	0.00368	0.0028	0.00191
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	43.3	54.7	70.0	91.5	123.5	175.3	269.6	479.5
100	Q_{QT}	0.01119	0.01664	0.02111	0.02543	0.02990	0.03474	0.04012	0.04629	0.04824	0.04409	0.03990	0.03559	0.03107	0.02620
	Q_{QC}	0.00170	0.00259	0.00330	0.00395	0.00458	0.00522	0.00590	0.00662	0.00668	0.00588	0.00508	0.00428	0.00348	0.00267
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	44.4	56.6	73.7	99.2	140.7	217.3

Table 6. FREE FLOW EMISSION RATE Q_f, IN GRAMS PER METER-SECOND AS A FUNCTION OF LANE VOLUME AND VEHICLE SPEED ON ROADWAYS.

Cruise speed (mi/hr)	Traffic volume for lane (vehicles per hour)													
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
15	0.00086	0.00171	0.00257	0.00342	0.00428	0.00514	0.00599	0.00685	0.00770	0.00856	0.00942	0.01027	0.01113	0.01198
20	0.00059	0.00119	0.00178	0.00237	0.00296	0.00356	0.00415	0.00474	0.00533	0.00593	0.00652	0.00711	0.00770	0.00830
25	0.00045	0.00090	0.00135	0.00180	0.00225	0.00270	0.00315	0.00361	0.00406	0.00451	0.00496	0.00541	0.00586	0.00631
30	0.00037	0.00074	0.00111	0.00148	0.00185	0.00222	0.00259	0.00296	0.00333	0.00370	0.00406	0.00443	0.00480	0.00517
35	0.00032	0.00065	0.00097	0.00129	0.00162	0.00194	0.00226	0.00258	0.00291	0.00323	0.00355	0.00388	0.00420	0.00452
40	0.00030	0.00060	0.00090	0.00119	0.00149	0.00179	0.00209	0.00239	0.00269	0.00298	0.00328	0.00358	0.00388	0.00418
45	0.00029	0.00058	0.00086	0.00115	0.00144	0.00173	0.00202	0.00230	0.00259	0.00288	0.00317	0.00346	0.00374	0.00403

Table 7. TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 15 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.02945	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.01604	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01056	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.00777	0.05160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00039	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.00619	0.04640	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.00522	0.02456	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.00460	0.01662	0.05237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00109	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.1033	0.01119	0.01205
	Queue	40.0	40.0	96.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 15 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.00419	0.01276	0.04331	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.00391	0.01059	0.02647	0.05351	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00127	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.00372	0.00928	0.01959	0.05036	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.00358	0.00844	0.01605	0.03164	0.05622	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00252	0.00517	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.00348	0.00787	0.01399	0.02405	0.04697	0.05494	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00142	0.00603	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.00341	0.00748	0.01269	0.02014	0.03293	0.06221	0.05369	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00494	0.00064	0.00689	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	41.8	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.00336	0.00720	0.01184	0.01785	0.02659	0.04208	0.06211	0.05278	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00086	0.00172	0.00258	0.00344	0.00430	0.00517	0.00446	0.00016	0.00775	0.00861	0.00947	0.01033	0.01119	0.01205
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	54.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 20 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.03064	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.01725	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01177	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.00898	0.05215	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00048	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.00739	0.04882	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.00643	0.02698	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.00581	0.01904	0.05391	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00135	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	96.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 20 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.00540	0.01517	0.04693	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.00512	0.01301	0.03010	0.05530	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00157	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.00493	0.01170	0.02322	0.05520	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.00479	0.01085	0.01968	0.03647	0.05975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00310	0.00636	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.00469	0.01029	0.01761	0.02889	0.05301	0.05694	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00175	0.00742	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	165.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.00462	0.00990	0.01632	0.02497	0.03898	0.06915	0.05459	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00608	0.00078	0.00848	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	41.8	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.00456	0.00962	0.01547	0.02269	0.03264	0.04934	0.06838	0.05301	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00106	0.00212	0.00318	0.00424	0.00530	0.00636	0.00549	0.00020	0.00954	0.01060	0.01166	0.01272	0.01377	0.01483
	Queue	40.0	40.0	40.0	40.0	40.0	41.8		1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 25 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.03205	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.01864	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01316	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.01037	0.05278	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00057	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.00879	0.05160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.00782	0.02976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.0511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.00720	0.02182	0.05568	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00136	0.00252	0.00160	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	94.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 25 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.00679	0.01796	0.05111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.00651	0.01580	0.03427	0.05736	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00186	0.00630	0.00756	0.00881	0.01007	0.01133	0.01239	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.0632	0.01448	0.02760	0.06076	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.00618	0.01364	0.02385	0.04204	0.06382	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00368	0.00756	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.00608	0.01307	0.02179	0.03445	0.05997	0.05924	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00208	0.00881	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.00601	0.01268	0.02950	0.03054	0.04593	0.07713	0.05561	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00723	0.00083	0.01007	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	41.8	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.00596	0.01261	0.01964	0.02825	0.03960	0.05769	0.07559	0.05326	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00126	0.00252	0.00378	0.00504	0.00630	0.00756	0.00653	0.00023	0.01133	0.01259	0.01385	0.01511	0.01637	0.01763
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	56.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 30 mi/hr)													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.03369	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.02028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01480	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.01201	0.05352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00067	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.01062	0.05488	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.00946	0.03304	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.0282
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.00884	0.02510	0.05776	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00189	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 30 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.00843	0.02123	0.05602	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.00815	0.01907	0.03919	0.05977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00496	0.00220	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.00796	0.01776	0.03231	0.06732	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.00782	0.01691	0.02876	0.04859	0.06861	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00435	0.00892	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.00772	0.01635	0.02670	0.04101	0.06816	0.06195	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00246	0.01041	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.00765	0.01596	0.02541	0.03709	0.05412	0.08653	0.05682	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00853	0.00110	0.01189	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	41.8	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.00759	0.01568	0.02456	0.03481	0.04778	0.06751	0.08408	0.05357	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00149	0.00297	0.00446	0.00595	0.00743	0.00892	0.00771	0.00028	0.01338	0.01487	0.01635	0.01784	0.01933	0.02082
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	54.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (QQC), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 35 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.03564	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.02223	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01674	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.01396	0.05440	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00080	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.01127	0.05877	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.01140	0.03693	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.01079	0.02899	0.06023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00225	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	94.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 35 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.01038	0.02513	0.06187	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.01010	0.02297	0.04503	0.06265	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00261	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.00990	0.02165	0.03815	0.07511	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.00977	0.02081	0.03461	0.05638	0.07431	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00517	0.01062	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.00967	0.02024	0.03254	0.04880	0.07790	0.06518	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.00293	0.01239	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.00959	0.01985	0.03125	0.4488	0.6386	0.09771	0.05826	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01015	0.00131	0.01415	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.00954	0.01958	0.03040	0.04260	0.05752	0.007920	0.09418	0.05393	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00177	0.00354	0.00531	0.00708	0.00885	0.01062	0.00917	0.00033	0.01592	0.01769	0.01946	0.02123	0.02300	0.02477
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	54.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 40 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.03796	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.0640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.02455	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.01987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.01628	0.05545	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00896	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.2134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.01469	0.06362	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.01373	0.04157	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.01311	0.03363	0.06318	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00271	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	96.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 40 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.01270	0.02977	0.06883	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.0.2347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.01242	0.02761	0.05200	0.06608	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00315	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.01222	0.02630	0.04512	0.08439	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.01209	0.02545	0.04157	0.06567	0.08110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QT}	0.00213	0.00427	0.00640	0.00854	0.00626	0.01280	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.01199	0.02489	0.03951	0.05808	0.08951	0.06902	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.00353	0.01494	0.01707	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.01192	0.02450	0.03951	0.05417	0.07547	0.11103	0.05998	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01225	0.00158	0.01707	0.01921	0.02134	0.02347	0.02561	0.01773	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.01186	0.02422	0.03736	0.05188	0.06913	0.09313	0.10622	0.05436	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00213	0.00427	0.00640	0.00854	0.01067	0.01280	0.01106	0.0039	0.01921	0.02134	0.02347	0.02561	0.02774	0.02988
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	54.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicles/hour) cruise speed is 45 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
1400	Q_{QT}	0.04072	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01826	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1300	Q_{QT}	0.02731	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1200	Q_{QT}	0.02182	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1100	Q_{QT}	0.01904	0.05670	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00118	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	176.9	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
1000	Q_{QT}	0.01745	0.06894	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
900	Q_{QT}	0.01649	0.04709	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
800	Q_{QT}	0.01587	0.03915	0.06669	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00331	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	94.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table 7 (continued). TOTAL QUEUE EMISSIONS, (Q_{QT}), CRUISE COMPONENT EMISSION, (Q_{QC}), AND QUEUE LENGTH AS A FUNCTION OF MAJOR AND CROSS-STREET VOLUMES AND CRUISE SPEED - UNSIGNALIZED INTERSECTIONS

Cross-street effective lane volume (veh/hr)	Element	Major street volume (vehicle/hour) cruise speed is 45 mi/hr													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
700	Q_{QT}	0.01546	0.03529	0.07711	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
600	Q_{QT}	0.01518	0.03313	0.06027	0.07016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.00385	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	108.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
500	Q_{QT}	0.01498	0.03181	0.05339	0.09543	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
400	Q_{QT}	0.01485	0.03097	0.04985	0.07670	0.00917	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.00763	0.01565	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	68.4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
300	Q_{QT}	0.01475	0.03040	0.04779	0.06912	0.10330	0.07358	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00761	0.00522	0.00782	0.01043	0.01304	0.00431	0.01825	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	145.1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
200	Q_{QT}	0.01468	0.03001	0.04649	0.06521	0.08926	0.12686	0.06201	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01496	0.00193	0.02086	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	41.8	379.3	40.0	40.0	40.0	40.0	40.0	40.0	40.0
100	Q_{QT}	0.01462	0.02976	0.04564	0.06292	0.08293	0.10968	0.12053	0.05487	0.0	0.0	0.0	0.0	0.0	0.0
	Q_{QC}	0.00261	0.00522	0.00782	0.01043	0.01304	0.01565	0.01352	0.00048	0.02347	0.02608	0.02868	0.03129	0.03390	0.03651
	Queue	40.0	40.0	40.0	40.0	40.0	40.0	54.0	1729.4	40.0	40.0	40.0	40.0	40.0	40.0

Table 8. EMISSION CORRECTION FACTORS FOR REGION, CALENDAR YEAR, SPEED, PERCENT COLD STARTS (C) PERCENT HOT STARTS (H) AND TEMPERATURE (T) BY VEHICLE TYPE (M)

EMISSION CORRECTION FACTORS FOR REGION: LOW ALTITUDE

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45
M	H	C	T																								
LDV	20	10	20	1.22	1.30	1.37	1.42	1.00	1.11	1.17	1.22	0.74	0.83	0.89	0.93	0.47	0.52	0.57	0.60	0.38	0.40	0.44	0.46	0.31	0.30	0.33	0.35
	20	10	40	1.12	1.18	1.23	1.26	0.91	0.99	1.04	1.08	0.67	0.75	0.79	0.82	0.43	0.47	0.51	0.54	0.35	0.37	0.40	0.42	0.29	0.28	0.31	0.32
	20	35	20	1.94	2.17	2.39	2.58	1.64	1.88	2.09	2.25	1.25	1.43	1.59	1.72	0.85	0.92	1.04	1.13	0.71	0.72	0.81	0.88	0.61	0.57	0.64	0.69
	20	35	40	1.57	1.74	1.90	2.03	1.31	1.49	1.63	1.75	1.00	1.13	1.25	1.35	0.69	0.75	0.84	0.90	0.59	0.60	0.67	0.73	0.52	0.49	0.55	0.60
	20	60	20	2.65	3.03	3.42	3.74	2.28	2.66	3.00	3.29	1.75	2.03	2.29	2.51	1.22	1.33	1.50	1.65	1.03	1.04	1.19	1.30	0.90	0.83	0.94	1.00
	20	60	40	2.03	2.30	2.57	2.81	1.72	1.98	2.23	2.43	1.33	1.52	1.71	1.87	0.96	1.03	1.16	1.27	0.84	0.84	0.95	1.04	0.75	0.70	0.79	0.87
	40	10	20	1.24	1.32	1.39	1.44	1.02	1.12	1.19	1.24	0.75	0.85	0.90	0.95	0.49	0.54	0.58	0.61	0.39	0.41	0.45	0.48	0.33	0.32	0.35	0.37
	40	10	40	1.14	1.20	1.25	1.28	0.92	1.01	1.06	1.09	0.68	0.76	0.81	0.84	0.44	0.49	0.53	0.55	0.36	0.38	0.41	0.43	0.30	0.29	0.32	0.34
	40	35	20	1.96	2.19	2.41	2.60	1.66	1.90	2.10	2.27	1.26	1.44	1.61	1.73	0.86	0.94	1.05	1.14	0.72	0.74	0.83	0.90	0.62	0.58	0.65	0.71
	40	35	40	1.60	1.76	1.92	2.05	1.33	1.50	1.65	1.77	1.01	1.15	1.27	1.36	0.71	0.76	0.85	0.92	0.61	0.62	0.69	0.74	0.54	0.50	0.56	0.61
	40	60	20	2.67	3.05	3.44	3.76	2.30	2.68	3.02	3.30	1.76	2.04	2.31	2.52	1.23	1.34	1.52	1.66	1.05	1.06	1.20	1.32	0.91	0.84	0.96	1.05
	40	60	40	2.05	2.32	2.60	2.83	1.73	2.00	2.24	2.44	1.34	1.53	1.73	1.88	0.97	1.04	1.18	1.28	0.85	0.85	0.97	1.06	0.77	9.71	0.81	0.88
LDT	20	10	20	3.16	3.17	3.35	3.51	2.86	3.00	3.19	3.34	2.50	2.83	3.04	3.19	0.97	1.18	1.27	1.34	1.53	1.99	2.15	2.26	0.52	0.76	0.83	0.87
	20	10	40	2.94	2.91	3.06	3.18	2.65	2.74	2.89	3.01	2.30	2.56	2.72	2.84	0.88	1.06	1.14	1.19	1.40	1.79	1.91	2.00	0.47	0.68	0.74	0.77
	20	35	20	4.80	5.11	5.65	6.10	4.38	4.92	5.45	5.90	3.94	4.76	5.30	5.75	1.55	2.00	2.23	2.42	2.44	3.36	3.76	4.07	0.83	1.30	1.46	1.58
	20	35	40	4.03	4.22	4.62	4.97	3.65	4.00	4.40	4.73	3.23	3.79	4.19	4.52	1.26	1.58	1.75	1.89	1.99	2.65	2.95	3.17	0.67	1.02	1.14	1.23
	20	60	20	6.43	7.05	7.95	8.70	5.91	6.84	7.72	8.46	5.37	6.69	7.57	8.30	2.13	2.81	3.18	3.49	3.36	4.74	5.36	5.88	1.15	1.84	2.09	2.29
	20	60	40	5.11	5.52	6.19	6.76	4.66	5.26	5.91	6.45	4.16	5.03	5.66	6.19	1.63	2.10	2.36	2.58	2.50	3.52	3.98	4.35	0.88	1.36	1.54	1.68
	40	10	20	3.21	3.22	3.40	3.55	2.90	3.04	3.23	3.39	2.54	2.87	3.08	3.23	0.98	1.20	1.29	1.36	1.55	2.01	2.17	2.28	0.52	0.77	0.84	0.88
	40	10	40	2.99	2.96	3.10	3.23	2.69	2.78	2.93	3.05	2.33	2.59	2.76	2.88	0.90	1.08	1.15	1.20	1.42	1.81	1.94	2.03	0.48	0.69	0.75	0.78
	40	35	20	4.84	5.16	5.69	6.15	4.42	4.96	5.49	5.94	3.97	4.80	5.34	5.79	1.56	2.01	2.24	2.43	2.47	3.39	3.78	4.10	0.84	1.31	1.47	1.59
	40	35	40	4.08	4.26	4.67	5.02	3.70	4.04	4.44	4.77	3.26	3.83	4.23	4.56	1.27	1.59	1.77	1.90	2.01	2.68	2.97	3.20	0.68	1.03	1.15	1.24
	40	60	20	6.47	7.10	7.99	8.75	5.95	6.88	7.76	8.50	5.41	6.73	7.61	8.34	2.14	2.83	3.20	3.51	3.38	4.76	5.39	5.91	1.15	1.85	2.10	2.30
	40	60	40	5.16	5.56	6.24	6.80	4.70	5.30	5.95	6.50	4.19	5.07	5.70	6.23	1.64	2.11	2.38	2.60	2.60	3.55	4.00	4.37	0.88	1.37	1.55	1.69
MC	20	10	20	0.47	0.81	0.92	1.02	0.38	0.67	0.72	0.77	0.30	0.54	0.57	0.60	0.15	0.27	0.28	0.29	0.09	0.18	0.18	0.19	0.07	0.12	0.13	0.13
	20	10	40	0.42	0.73	0.83	0.92	0.34	0.59	0.64	0.68	0.27	0.48	0.50	0.52	0.13	0.24	0.25	0.25	0.08	0.15	0.16	0.16	0.06	0.11	0.11	0.11
	20	35	20	0.78	1.36	1.55	1.71	0.63	1.17	1.31	1.43	0.51	0.98	1.08	1.17	0.25	0.49	0.54	0.58	0.16	0.32	0.35	0.38	0.11	0.23	0.25	0.27
	20	35	40	0.62	1.08	1.23	1.35	0.50	0.91	1.01	1.10	0.40	0.75	0.82	0.89	0.20	0.38	0.41	0.44	0.13	0.24	0.26	0.28	0.09	0.17	0.19	0.20
	20	60	20	1.09	1.90	2.17	2.40	0.89	1.68	1.90	2.09	0.72	1.41	1.60	1.75	0.36	0.71	0.80	0.87	0.23	0.46	0.52	0.57	0.16	0.33	0.37	0.41
	20	60	40	0.81	1.42	1.62	1.79	0.66	1.23	1.39	1.52	0.53	1.02	1.15	1.26	0.26	0.51	0.57	0.63	0.17	0.33	0.37	0.41	0.12	0.24	0.27	0.29
	40	10	20	0.47	0.82	0.93	1.03	0.38	0.68	0.73	0.78	0.30	0.55	0.58	0.61	0.15	0.28	0.29	0.30	0.10	0.18	0.18	0.19	0.07	0.13	0.13	0.13
	40	10	40	0.43	0.74	0.84	0.92	0.34	0.60	0.65	0.69	0.27	0.49	0.51	0.53	0.14	0.24	0.25	0.26	0.09	0.16	0.16	0.16	0.06	0.11	0.11	0.11
	40	35	20	0.78	1.36	1.56	1.72	0.64	1.18	1.32	1.44	0.52	0.99	1.09	1.18	0.26	0.49	0.54	0.59	0.16	0.32	0.35	0.38	0.11	0.23	0.25	0.27
	40	35	40	0.62	1.08	1.24	1.36	0.50	0.92	1.02	1.11	0.40	0.76	0.83	0.89	0.20	0.38	0.41	0.44	0.13	0.25	0.27	0.29	0.09	0.18	0.19	0.20
	40	60	20	1.09	1.91	2.18	2.41	0.90	1.69	1.91	2.10	0.73	1.42	1.60	1.76	0.36	0.71	0.80	0.88	0.23	0.46	0.52	0.57	0.16	0.34	0.38	0.41
	40	60	40	0.82	1.43	1.63	1.80	0.66	1.24	1.39	1.53	0.53	1.03	1.16	1.26	0.26	0.52	0.58	0.63	0.17	0.34	0.38	0.41	0.12	0.24	0.27	0.29
HDG				1.72	5.80	5.51	6.36	1.73	5.54	5.62	6.56	1.73	5.23	5.77	6.91	1.57	3.97	4.67	5.68	1.52	3.21	3.91	4.78	1.55	2.52	3.20	3.95
HDD				0.83	0.62	0.60	0.62	0.83	0.60	0.57	0.57	0.83	0.60	0.55	0.53	0.83	0.59	0.53	0.51	0.83	0.59	0.52	0.51	0.83	0.59	0.52	0.50

Table 8 (continued). EMISSION CORRECTION FACTORS FOR REGION, CALENDAR YEAR, SPEED, PERCENT COLD STARTS (C) PERCENT HOT STARTS (H) AND TEMPERATURE (T) BY VEHICLE TYPE (M)

EMISSION CORRECTION FACTORS FOR REGION: HIGH ALTITUDE

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45
M	H	C	T																								
LDV	20	10	20	1.04	1.73	2.13	2.44	0.85	1.46	1.76	1.98	0.65	1.07	1.26	1.40	0.45	0.64	0.73	0.80	0.37	0.46	0.52	0.57	0.31	0.32	0.36	0.39
	20	10	40	0.93	1.56	1.93	2.22	0.76	1.30	1.58	1.78	0.58	0.96	1.13	1.26	0.40	0.58	0.66	0.72	0.34	0.42	0.48	0.51	0.29	0.30	0.33	0.36
	20	35	20	1.84	2.94	3.48	3.91	1.53	2.56	2.99	3.33	1.19	1.87	2.17	2.48	0.84	1.13	1.29	1.42	0.71	0.83	0.95	1.04	0.61	0.60	0.68	0.75
	20	35	40	1.48	2.34	2.79	3.14	1.21	2.00	2.35	2.62	0.94	1.47	1.71	1.90	0.68	0.91	1.04	1.15	0.59	0.69	0.79	0.86	0.52	0.52	0.59	0.64
	20	60	20	2.65	4.16	4.83	5.38	2.22	3.65	4.22	4.68	1.73	2.67	3.07	3.40	1.22	1.62	1.86	2.05	1.04	1.20	1.38	1.52	0.90	0.88	1.00	1.10
	20	60	40	2.02	3.13	3.65	4.07	1.66	2.69	3.11	3.46	1.30	1.99	2.29	2.58	0.96	1.25	1.43	1.57	0.85	0.96	1.10	1.21	0.76	0.74	0.84	0.92
	40	10	20	1.03	1.71	2.11	2.41	0.85	1.46	1.75	1.97	0.65	1.07	1.26	1.40	0.46	0.65	0.74	0.81	0.38	0.47	0.54	0.58	0.32	0.33	0.37	0.40
	40	10	40	0.92	1.54	1.91	2.19	0.75	1.30	1.57	1.76	0.58	0.96	1.13	1.26	0.41	0.58	0.67	0.73	0.35	0.43	0.49	0.53	0.30	0.31	0.35	0.37
	40	35	20	1.83	2.93	3.46	3.88	1.53	2.55	2.98	3.32	1.19	1.87	2.17	2.48	0.84	1.14	1.30	1.43	0.72	0.84	0.96	1.05	0.62	0.61	0.70	0.76
	40	35	40	1.47	2.33	2.77	3.12	1.20	1.99	2.34	2.60	0.94	1.47	1.71	1.89	0.69	0.92	1.05	1.16	0.61	0.70	0.80	0.87	0.54	0.53	0.60	0.65
	40	60	20	2.64	4.14	4.81	5.35	2.21	3.65	4.21	4.67	1.73	2.67	3.07	3.40	1.23	1.63	1.87	2.06	1.06	1.22	1.39	1.53	0.92	0.89	1.02	1.12
	40	60	40	2.01	3.11	3.63	4.04	1.66	2.68	3.10	3.44	1.31	1.99	2.29	2.53	0.97	1.26	1.44	1.58	0.86	0.97	1.11	1.22	0.78	0.75	0.85	0.94
LDT	20	10	20	3.93	4.40	5.54	6.42	3.43	4.04	5.00	5.74	2.88	3.74	4.53	5.12	1.06	1.46	1.73	1.92	1.63	2.33	2.74	3.03	0.54	0.85	0.98	1.08
	20	10	40	3.57	4.02	5.11	5.94	3.12	3.66	4.57	5.26	2.60	3.35	4.08	4.62	0.96	1.30	1.55	1.73	1.48	2.09	2.46	2.73	0.49	0.76	0.88	0.96
	20	35	20	6.77	7.28	8.69	9.82	5.86	6.78	8.04	9.03	4.95	6.42	7.53	8.41	1.81	2.49	2.90	3.21	2.77	3.97	4.60	5.09	0.91	1.45	1.67	1.84
	20	35	40	5.51	5.95	7.17	8.14	4.77	5.46	6.52	7.36	3.99	5.06	5.97	6.68	1.46	1.96	2.29	2.54	2.28	3.13	3.64	4.03	0.74	1.13	1.31	1.44
	20	60	20	9.62	10.16	11.85	13.23	8.29	9.52	11.07	12.33	7.03	9.11	10.53	11.70	2.57	3.53	4.07	4.50	3.91	5.61	6.46	7.14	1.29	2.05	2.35	2.59
	20	60	40	7.45	7.88	9.24	10.35	6.43	7.26	8.48	9.47	5.38	6.78	7.86	8.74	1.96	2.62	3.03	3.35	3.00	4.17	4.81	5.32	0.99	1.51	1.74	1.92
	40	10	20	3.88	4.35	5.46	6.32	3.38	4.00	4.95	5.67	2.85	3.72	4.49	5.07	1.05	1.45	1.72	1.92	1.62	2.33	2.73	3.02	0.54	0.85	0.98	1.08
	40	10	40	3.52	3.97	5.03	5.84	3.07	3.62	4.51	5.19	2.58	3.33	4.05	4.58	0.95	1.30	1.55	1.72	1.47	2.09	2.46	2.72	0.49	0.76	0.88	0.96
	40	35	20	6.72	7.22	8.62	9.73	5.82	6.74	7.98	8.96	4.93	6.40	7.50	8.37	1.81	2.49	2.89	3.21	2.76	3.97	4.59	5.08	0.91	1.45	1.67	1.83
	40	35	40	5.46	5.90	7.10	8.05	4.73	5.42	6.47	7.29	3.97	5.04	5.94	6.64	1.45	1.96	2.28	2.53	2.23	3.13	3.63	4.02	0.74	1.14	1.31	1.44
	40	60	20	9.56	10.10	11.77	13.13	8.25	9.48	11.01	12.26	7.00	9.09	10.50	11.66	2.56	3.53	4.06	4.49	3.90	5.61	6.45	7.14	1.29	2.05	2.35	2.59
	40	60	40	7.40	7.82	9.16	10.25	6.38	7.22	8.42	9.40	5.35	6.75	7.83	8.70	1.95	2.62	3.02	3.34	2.99	4.17	4.80	5.31	0.98	1.51	1.74	1.92
MC	20	10	20	1.45	1.09	1.39	1.63	0.88	0.88	1.12	1.32	0.58	0.70	0.90	1.05	0.26	0.34	0.44	0.52	0.14	0.20	0.26	0.30	0.08	0.13	0.16	0.19
	20	10	40	1.28	0.98	1.26	1.50	0.77	0.78	1.01	1.19	0.50	0.62	0.80	0.94	0.23	0.30	0.39	0.46	0.12	0.18	0.23	0.27	0.07	0.11	0.14	0.17
	20	35	20	2.67	1.84	2.21	2.52	1.66	1.57	1.89	2.14	1.12	1.30	1.55	1.76	0.50	0.63	0.76	0.86	0.27	0.37	0.45	0.51	0.16	0.24	0.29	0.33
	20	35	40	2.08	1.45	1.77	2.03	1.28	1.21	1.47	1.69	0.85	0.99	1.20	1.37	0.38	0.48	0.59	0.67	0.21	0.28	0.35	0.39	0.12	0.18	0.22	0.25
	20	60	20	3.90	2.59	3.03	3.40	2.44	2.27	2.65	2.96	1.66	1.89	2.21	2.47	0.75	0.92	1.08	1.20	0.41	0.55	0.64	0.71	0.24	0.35	0.41	0.46
	20	60	40	2.88	1.93	2.27	2.56	1.79	1.65	1.94	2.18	1.20	1.36	1.60	1.79	0.54	0.67	0.78	0.88	0.29	0.39	0.46	0.52	0.17	0.25	0.30	0.33
	40	10	20	1.43	1.08	1.38	1.62	0.87	0.87	1.11	1.30	0.57	0.69	0.89	1.04	0.26	0.34	0.43	0.51	0.14	0.20	0.25	0.30	0.08	0.13	0.16	0.19
	40	10	40	1.27	0.97	1.25	1.48	0.76	0.77	0.99	1.17	0.50	0.61	0.78	0.93	0.22	0.30	0.38	0.45	0.12	0.17	0.22	0.26	0.07	0.11	0.14	0.17
	40	35	20	2.66	1.83	2.20	2.50	1.65	1.56	1.87	2.12	1.11	1.29	1.54	1.74	0.50	0.63	0.75	0.85	0.27	0.37	0.44	0.50	0.16	0.24	0.29	0.32
	40	35	40	2.07	1.44	1.76	2.01	1.27	1.20	1.46	1.67	0.84	0.98	1.19	1.35	0.38	0.48	0.58	0.66	0.21	0.28	0.34	0.39	0.12	0.18	0.22	0.25
	40	60	20	3.88	2.58	3.02	3.38	2.44	2.26	2.64	2.95	1.65	1.88	2.19	2.45	0.74	0.92	1.07	1.20	0.41	0.54	0.63	0.71	0.24	0.35	0.41	0.46
	40	60	40	2.87	1.92	2.26	2.54	1.78	1.64	1.93	2.16	1.19	1.35	1.59	1.78	0.54	0.66	0.78	0.87	0.29	0.39	0.46	0.51	0.17	0.25	0.30	0.33
HDG				2.36	8.61	8.19	9.48	2.29	8.13	8.29	9.70	2.18	7.61	8.46	10.15	1.83	5.52	6.51	7.93	1.69	4.22	5.11	6.25	1.62	3.02	3.79	4.66
HDD				0.08	1.01	0.97	1.00	0.08	0.98	0.92	0.92	0.07	0.97	0.88	0.87	0.06	0.86	0.77	0.74	0.04	0.78	0.66	0.63	0.03	0.65	0.57	0.55

Table 8 (continued). EMISSION CORRECTION FACTORS FOR REGION, CALENDAR YEAR, SPEED, PERCENT COLD STARTS (C) PERCENT HOT STARTS (H) AND TEMPERATURE (T) BY VEHICLE TYPE (M)

EMISSION CORRECTION FACTORS FOR REGION: CALIFORNIA

			YEAR:	1978	1978	1978	1978	1980	1980	1980	1980	1982	1982	1982	1982	1985	1985	1985	1985	1987	1987	1987	1987	1990	1990	1990	1990
			SPEED:	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45
M	H	C	T																								
LDV	20	10	20	1.09	1.07	1.11	1.14	0.78	0.81	0.85	0.87	0.48	0.60	0.63	0.65	0.18	0.40	0.44	0.46	0.11	0.35	0.38	0.40	0.06	0.31	0.34	0.36
	20	10	40	1.02	1.00	1.02	1.04	0.69	0.76	0.79	0.80	0.41	0.56	0.59	0.61	0.17	0.38	0.41	0.43	0.10	0.32	0.35	0.37	0.06	0.29	0.32	0.33
	20	35	20	1.68	1.71	1.87	2.01	1.10	1.33	1.46	1.57	0.66	1.01	1.12	1.21	0.28	0.73	0.82	0.89	0.17	0.65	0.73	0.79	0.11	0.59	0.67	0.73
	20	35	40	1.41	1.45	1.58	1.68	0.96	1.14	1.25	1.33	0.58	0.88	0.97	1.04	0.24	0.64	0.72	0.78	0.15	0.57	0.64	0.69	0.10	0.52	0.58	0.63
	20	60	20	2.19	2.35	2.64	2.87	1.47	1.84	2.07	2.26	0.88	1.43	1.61	1.76	0.38	1.06	1.21	1.32	0.24	0.95	1.08	1.19	0.16	0.87	0.99	1.09
	20	60	40	1.79	1.91	2.14	2.32	1.22	1.52	1.71	1.86	0.74	1.20	1.35	1.47	0.32	0.91	1.03	1.12	0.20	0.81	0.92	1.01	0.13	0.75	0.85	0.93
	40	10	20	1.11	1.09	1.13	1.16	0.75	0.83	0.87	0.89	0.45	0.62	0.65	0.67	0.18	0.42	0.46	0.48	0.11	0.36	0.40	0.42	0.06	0.32	0.36	0.38
	40	10	40	1.04	1.02	1.05	1.06	0.71	0.78	0.81	0.82	0.42	0.58	0.61	0.63	0.17	0.40	0.43	0.45	0.10	0.34	0.37	0.39	0.06	0.30	0.33	0.35
	40	35	20	1.66	1.73	1.89	2.03	1.12	1.35	1.48	1.59	0.67	1.03	1.14	1.23	0.28	0.75	0.84	0.91	0.18	0.67	0.75	0.81	0.11	0.61	0.68	0.74
	40	35	40	1.43	1.48	1.60	1.70	0.97	1.16	1.27	1.35	0.58	0.90	0.99	1.06	0.25	0.66	0.74	0.79	0.15	0.59	0.66	0.71	0.10	0.53	0.60	0.65
	40	60	20	2.21	2.37	2.66	2.90	1.48	1.86	2.09	2.28	0.89	1.45	1.63	1.78	0.38	1.08	1.22	1.34	0.24	0.97	1.10	1.21	0.16	0.89	1.01	1.11
	40	60	40	1.81	1.93	2.16	2.34	1.23	1.55	1.73	1.88	0.75	1.22	1.37	1.49	0.32	0.92	1.05	1.14	0.21	0.83	0.94	1.03	0.14	0.76	0.87	0.95
LDT	20	10	20	3.23	3.05	3.10	3.12	2.81	2.69	2.76	2.79	2.32	2.27	2.34	2.38	0.81	0.85	0.89	0.90	1.27	1.40	1.47	1.51	0.45	0.55	0.59	0.61
	20	10	40	3.02	2.84	2.85	2.84	2.64	2.51	2.55	2.56	2.10	2.13	2.18	2.20	0.77	0.80	0.83	0.84	1.21	1.32	1.38	1.41	0.43	0.52	0.55	0.57
	20	35	20	5.05	4.92	5.34	5.68	4.46	4.40	4.80	5.11	3.71	3.75	4.10	4.38	1.32	1.42	1.57	1.68	2.09	2.40	2.65	2.84	0.77	0.97	1.08	1.17
	20	35	40	4.29	4.16	4.48	4.73	3.83	3.77	4.08	4.32	3.23	3.25	3.54	3.76	1.16	1.25	1.37	1.46	1.86	2.12	2.33	2.48	0.69	0.86	0.95	1.02
	20	60	20	6.87	6.78	7.59	8.25	6.10	6.10	6.84	7.44	5.10	5.22	5.86	6.38	1.82	2.00	2.25	2.45	2.91	3.39	3.82	4.17	1.09	1.39	1.58	1.72
	20	60	40	5.57	5.49	6.11	6.61	5.03	5.03	5.61	6.08	4.28	4.38	4.89	5.31	1.56	1.71	1.91	2.08	2.50	2.91	3.27	3.56	0.94	1.20	1.36	1.48
	40	10	20	3.31	3.12	3.17	3.18	2.89	2.77	2.83	2.86	2.39	2.34	2.42	2.45	0.84	0.88	0.91	0.93	1.32	1.46	1.53	1.57	0.47	0.58	0.61	0.64
	40	10	40	3.09	2.91	2.93	2.91	2.71	2.59	2.63	2.63	2.25	2.20	2.25	2.27	0.80	0.83	0.86	0.87	1.25	1.38	1.44	1.47	0.45	0.55	0.58	0.59
	40	35	20	5.13	4.99	5.41	5.75	4.53	4.47	4.87	5.19	3.78	3.82	4.17	4.45	1.35	1.46	1.60	1.71	2.14	2.45	2.70	2.90	0.79	1.00	1.11	1.19
	40	35	40	4.37	4.24	4.55	4.80	3.91	3.85	4.15	4.39	3.30	3.33	3.61	3.83	1.19	1.28	1.40	1.49	1.90	2.17	2.38	2.54	0.70	0.89	0.98	1.05
	40	60	20	6.95	6.86	7.66	8.31	6.17	6.18	6.91	7.51	5.17	5.29	5.93	6.45	1.85	2.03	2.28	2.48	2.95	3.45	3.88	4.23	1.10	1.42	1.60	1.75
	40	60	40	5.65	5.57	6.18	6.68	5.11	5.10	5.68	6.15	4.35	4.45	4.97	5.39	1.59	1.74	1.95	2.11	2.55	2.97	3.33	3.62	0.96	1.23	1.38	1.51
MC	20	10	20	0.66	0.83	0.95	1.04	0.56	0.69	0.76	0.81	0.48	0.56	0.61	0.64	0.26	0.29	0.31	0.32	0.17	0.18	0.20	0.20	0.12	0.13	0.13	0.14
	20	10	40	0.60	0.75	0.85	0.94	0.50	0.61	0.67	0.71	0.42	0.49	0.53	0.55	0.23	0.25	0.27	0.28	0.15	0.16	0.17	0.17	0.11	0.11	0.12	0.12
	20	35	20	1.10	1.39	1.58	1.75	0.99	1.21	1.36	1.49	0.87	1.02	1.14	1.24	0.47	0.52	0.58	0.63	0.32	0.34	0.37	0.40	0.23	0.24	0.26	0.28
	20	35	40	0.87	1.10	1.26	1.39	0.77	0.94	1.05	1.14	0.67	0.78	0.87	0.94	0.36	0.40	0.44	0.48	0.24	0.26	0.28	0.30	0.17	0.18	0.20	0.21
	20	60	20	1.54	1.94	2.22	2.46	1.42	1.73	1.97	2.17	1.26	1.48	1.67	1.84	0.69	0.75	0.85	0.94	0.46	0.49	0.55	0.60	0.33	0.34	0.39	0.43
	20	60	40	1.15	1.45	1.66	1.83	1.04	1.26	1.43	1.57	0.91	1.07	1.21	1.32	0.50	0.55	0.62	0.67	0.33	0.35	0.40	0.43	0.24	0.25	0.28	0.30
	40	10	20	0.67	0.84	0.96	1.05	0.57	0.69	0.76	0.82	0.49	0.57	0.61	0.65	0.26	0.29	0.31	0.32	0.18	0.19	0.20	0.20	0.12	0.13	0.14	0.14
	40	10	40	0.60	0.76	0.86	0.95	0.51	0.61	0.67	0.72	0.43	0.50	0.54	0.56	0.23	0.26	0.27	0.28	0.15	0.16	0.17	0.18	0.11	0.11	0.12	0.12
	40	35	20	1.11	1.39	1.59	1.76	1.00	1.22	1.37	1.49	0.88	1.03	1.15	1.25	0.48	0.52	0.58	0.63	0.32	0.34	0.38	0.41	0.23	0.24	0.26	0.28
	40	35	40	0.88	1.11	1.27	1.40	0.78	0.94	1.06	1.15	0.67	0.79	0.87	0.94	0.37	0.40	0.45	0.48	0.24	0.26	0.29	0.31	0.17	0.18	0.20	0.21
	40	60	20	1.55	1.95	2.23	2.46	1.43	1.74	1.98	2.17	1.26	1.48	1.68	1.84	0.69	0.76	0.86	0.94	0.46	0.49	0.55	0.61	0.33	0.35	0.39	0.43
	40	60	40	1.16	1.46	1.67	1.84	1.05	1.27	1.44	1.58	0.92	1.07	1.21	1.33	0.50	0.55	0.62	0.68	0.33	0.36	0.40	0.44	0.24	0.25	0.28	0.30
HDG				1.44	5.41	5.77	7.04	1.33	5.12	5.98	7.29	1.25	4.89	6.01	7.52	1.19	3.77	4.81	6.04	1.25	3.09	4.08	5.01	1.38	2.45	3.27	4.10
HDD				0.83	0.63	0.57	0.58	0.83	0.61	0.54	0.54	0.83	0.60	0.53	0.52	0.83	0.60	0.52	0.51	0.83	0.59	0.52	0.50	0.83	0.59	0.52	0.50

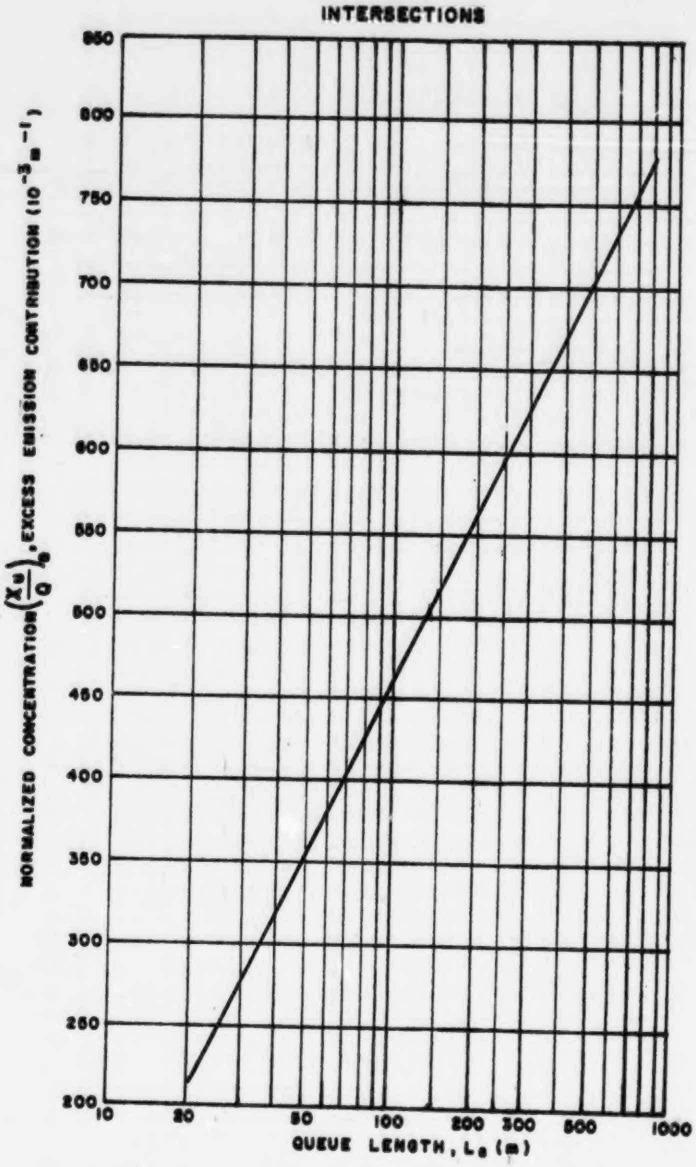


Figure 25. Normalized CO concentration contribution from excess emissions on approach 1 as a function of queue length on approach 1 for intersections

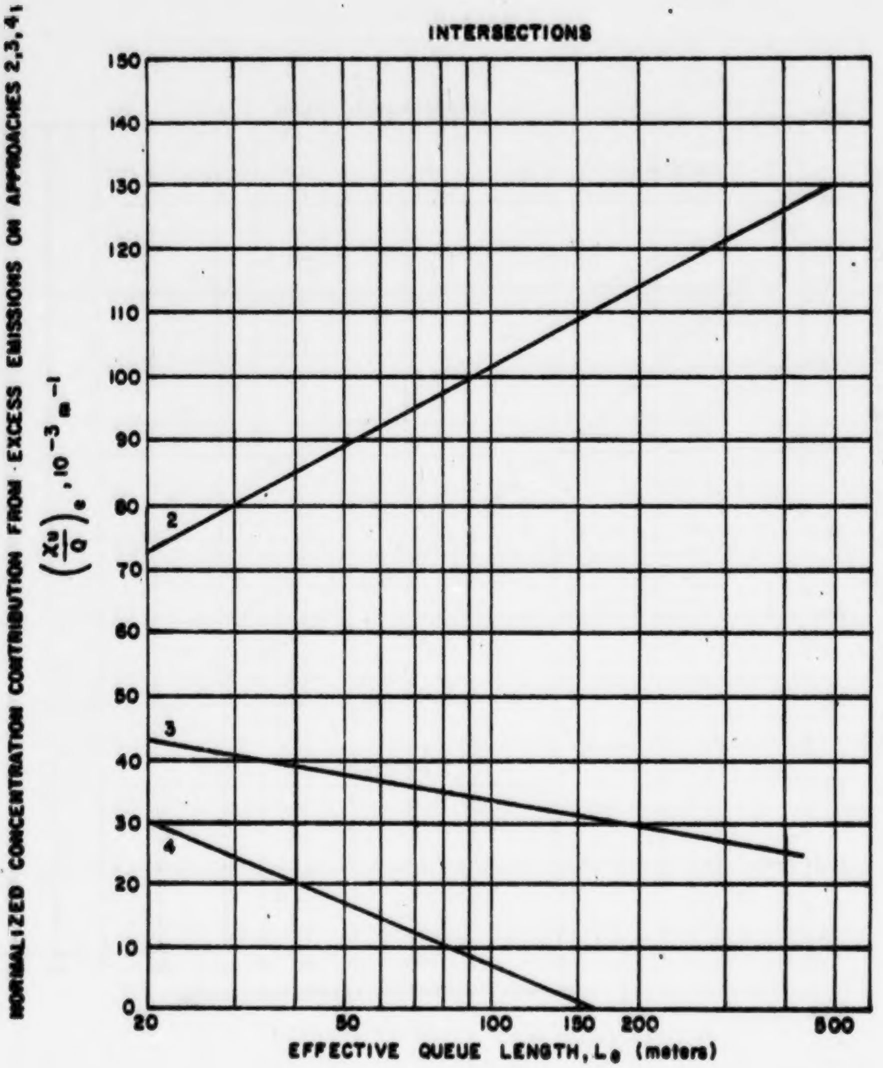


Figure 26. Normalized CO concentration contributions from excess emissions on approaches 2, 3, and 4 as a function of queue length on approach 1 for intersections

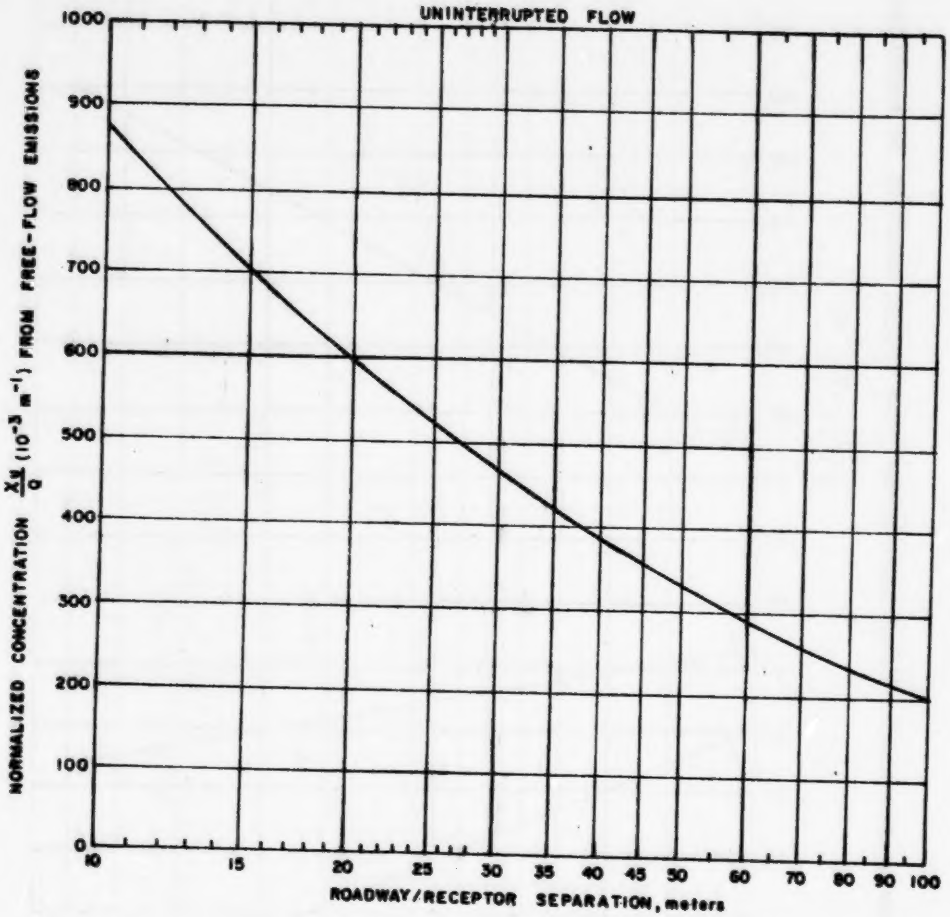


Figure 27. Normalized CO concentration contribution at each traffic stream at locations of uninterrupted flow

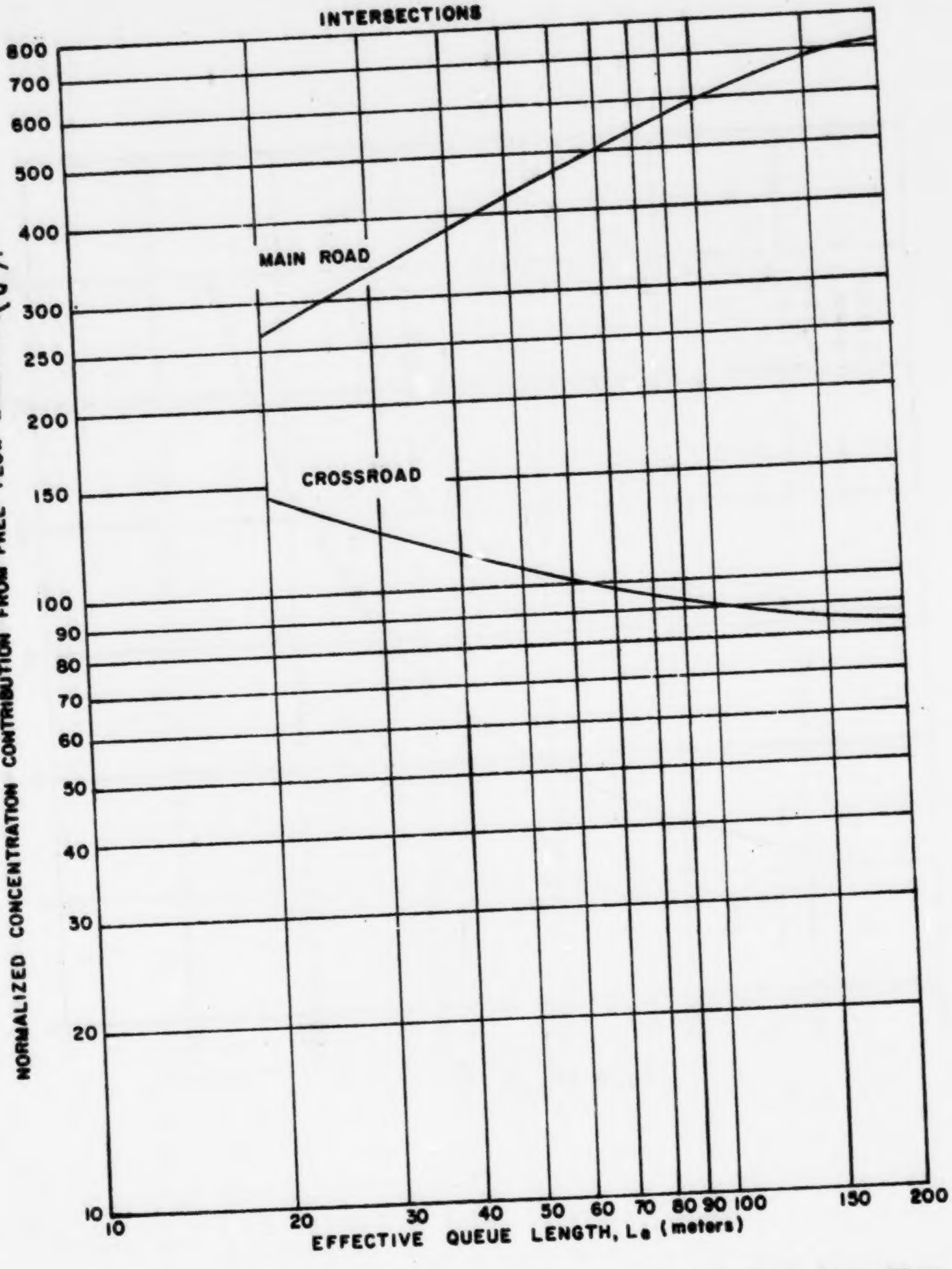


Figure 28. Normalized CO concentration contributions from free-flow emissions on each lane of roadways at intersections

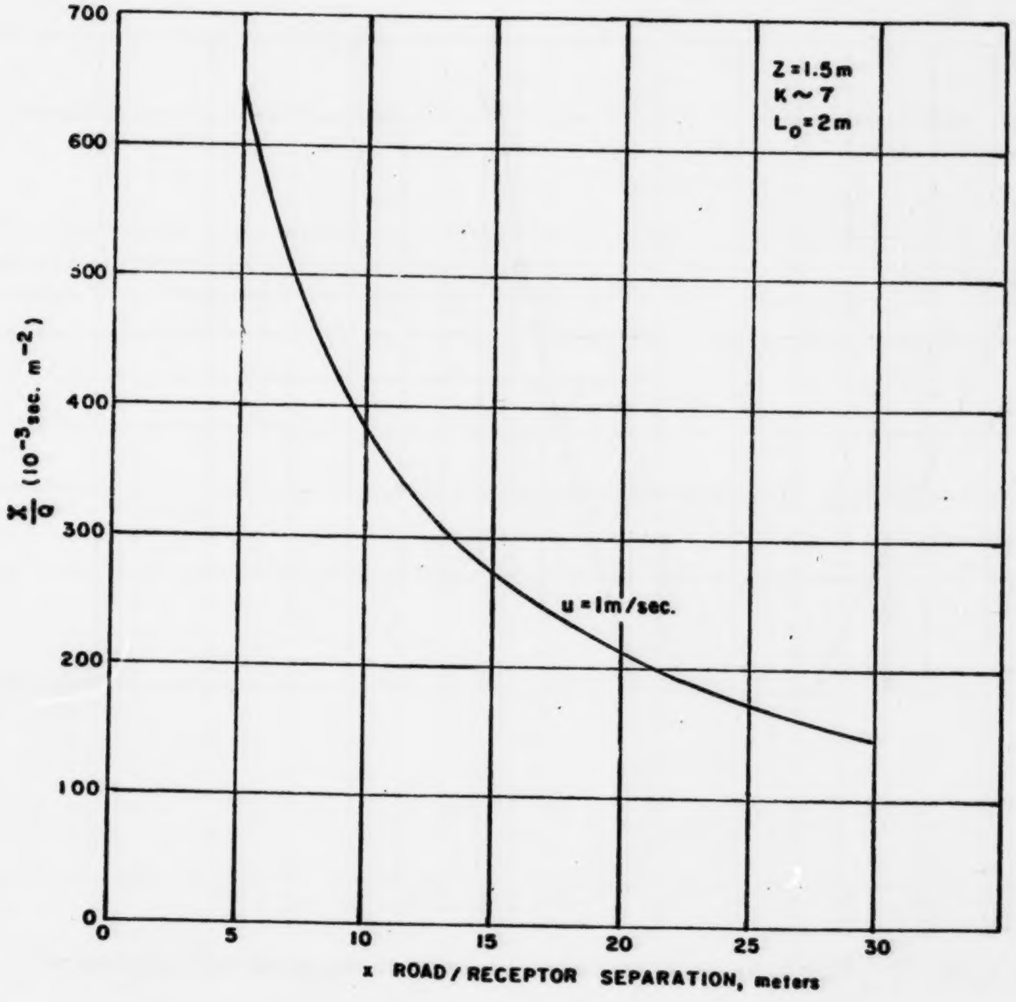


Figure 29. Normalized CO concentration in street-canyons assuming vortex has formed

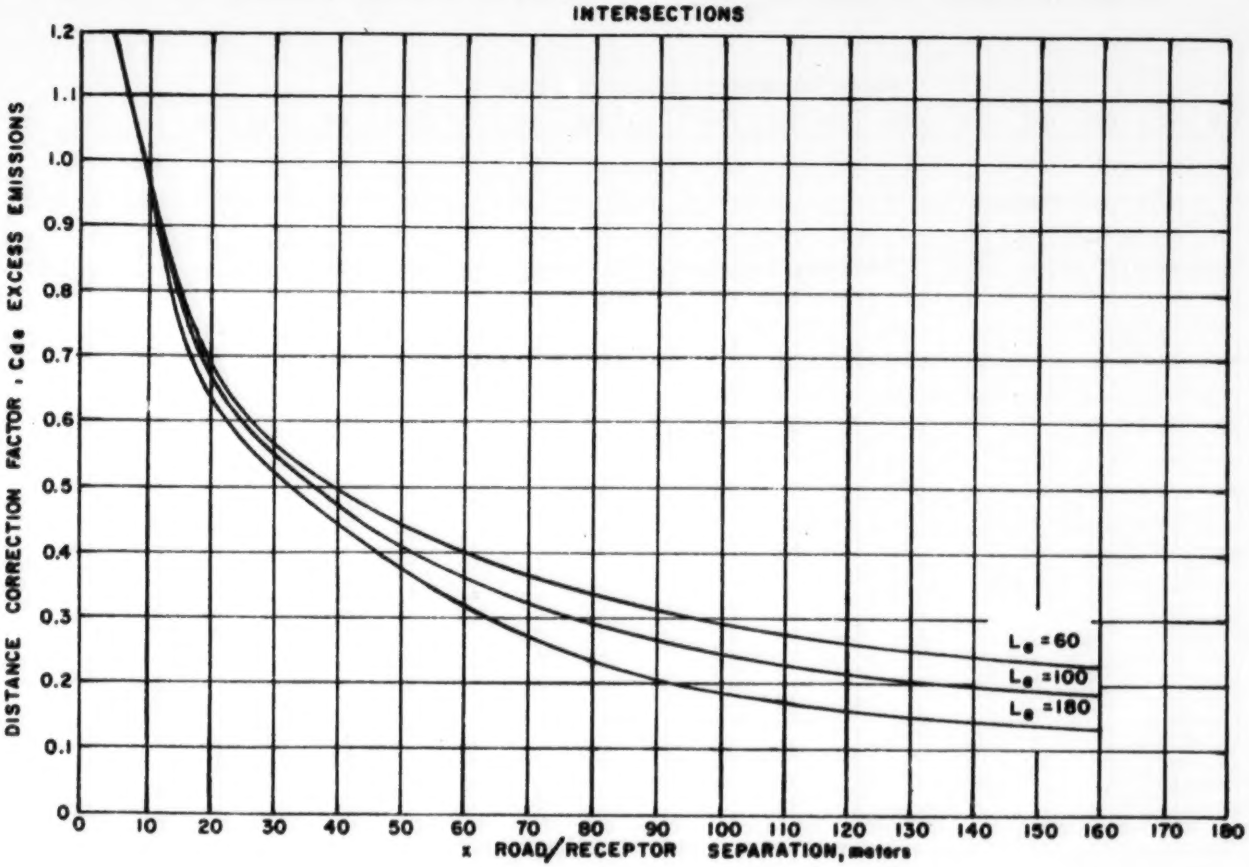


Figure 30. Distance correction factor for excess emission contributions at intersections

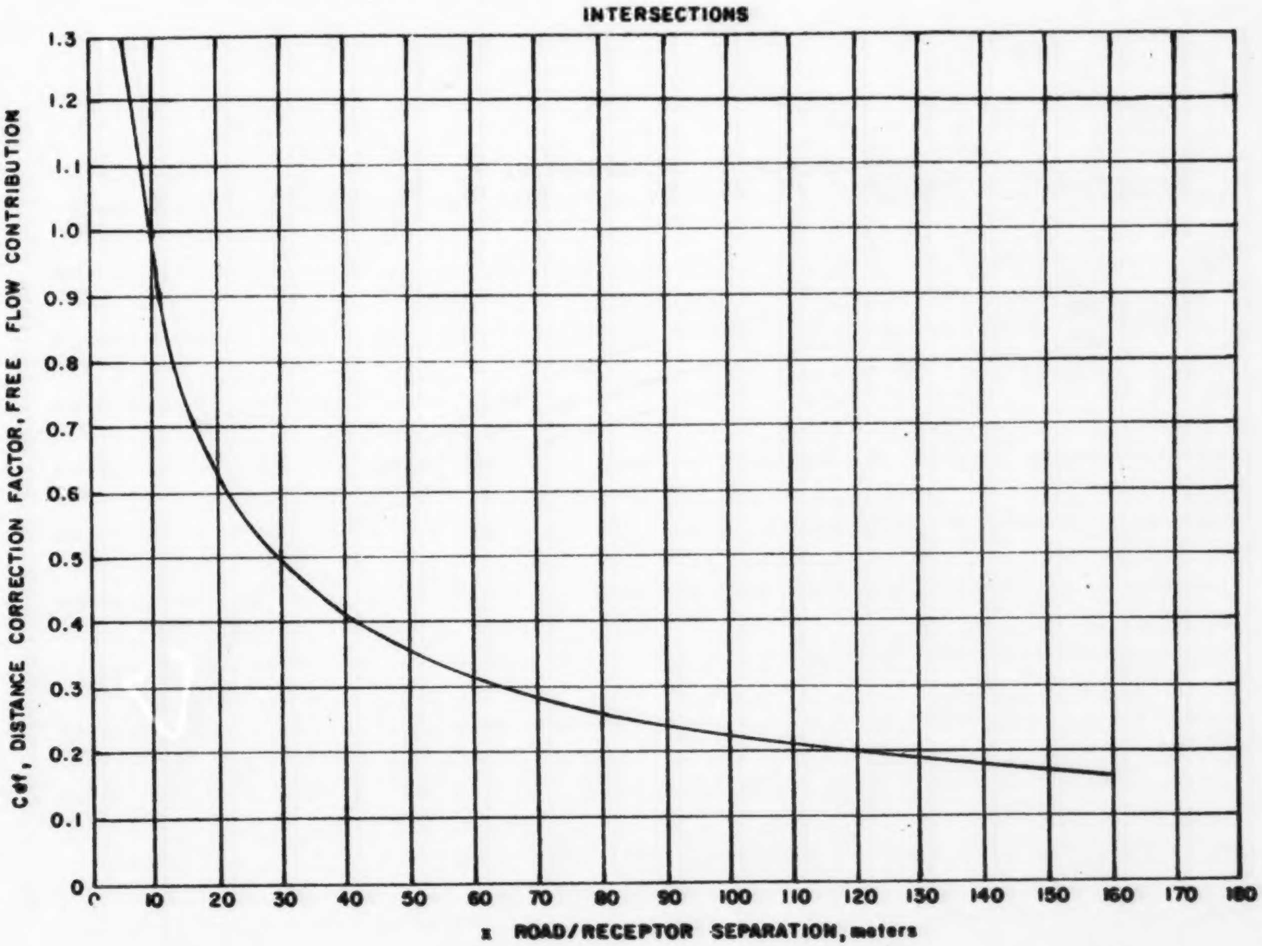


Figure 31. Distance correction factor for free-flow emission contributions at intersection locations

C. SPECIAL INSTRUCTIONS

Presented here are discussions on several topics that are directly relevant to hot spot analysis. These discussions serve to treat in detail several areas that are especially important in hot spot analysis, but which were only briefly discussed in previous sections of this document.

1. Optimum Receptor Siting

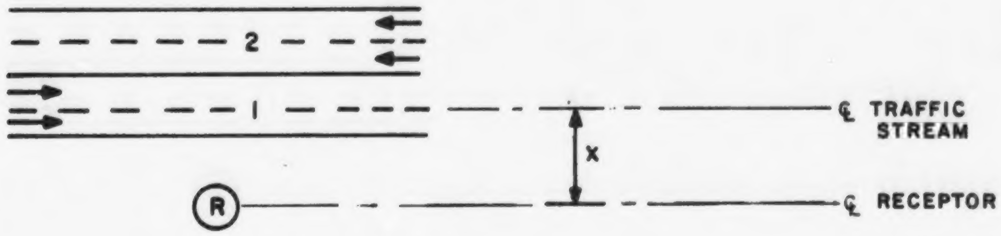
The location of the optimum receptor site is at the position where the maximum projected pollutant concentration is most likely to occur. The optimum receptor placement may be determined according to the following guidelines.

Uninterrupted flow locations:

(i) The optimum receptor site is on the side of the road that has the heaviest peak-hour traffic flow (vehicles/hour).

(ii) The receptor should be located at the minimum perpendicular distance, x, from the roadway consistent with the criteria for being a reasonable receptor site. For the purposes of hot spot verification, the most practical guidance that can be given is to assume the receptor to be located at the centerline of the adjacent sidewalk or at the right-of-way limit if no sidewalk exists.

(iii) Each traffic stream (all lanes in one direction of travel) should be assigned an identification number with regard to the receptor site as depicted below.



Intersection locations:

(i) The receptor should be located on an approach rather than the departure side of an intersection leg.

(ii) If all such approaches to the intersection have an equal number of approach lanes, the receptor should be located on the approach having the highest peak volume.

(iii) If the approaches have an unequal number of lanes, and the approach having the greatest number of lanes also has the highest lane volume, the receptor should be located on that approach.

(iv) If the approach having the largest number of lanes does not have the greatest lane volume, Table 5 and Figure 32 must be used to determine receptor placement. Enter Table 9 using the lane volume of the approach having the most lanes as V_{main} to determine the queue length, Le, which develops on that approach. Use this quantity to enter Figure 32 to determine the normalized concentrations, $\left(\frac{Xu}{Q}\right)_e$. Next, designate the largest lane volume as V_{main} and enter Table 5 to determine the queue length which develops on the corresponding approach. Again use Figure 32 to find the resulting normalized concentration $\left(\frac{Xu}{Q}\right)_e$. The receptor should be located on the approach which yields the highest $\left(\frac{Xu}{Q}\right)_e$ value.

(v) Each traffic stream (all lanes in one direction of travel) approaching the intersection should be assigned an identification number with regard to the receptor site as depicted below.

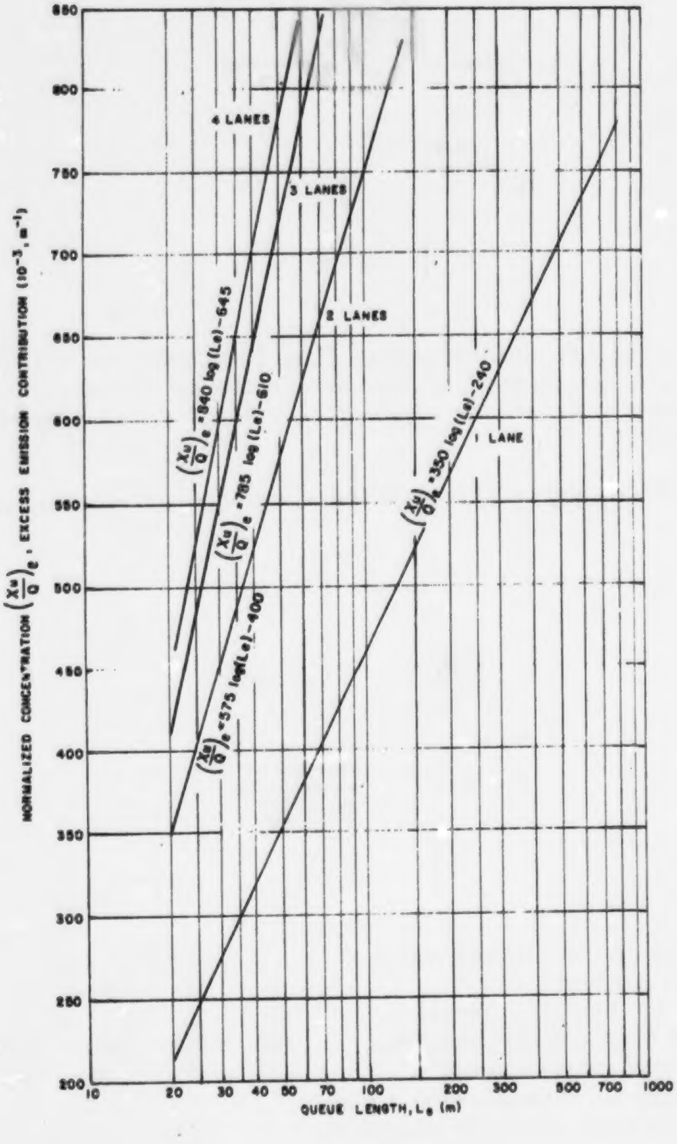
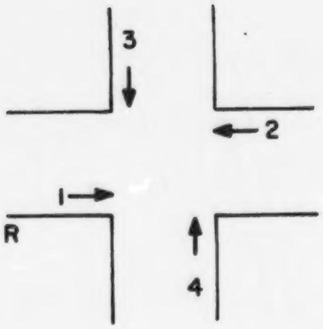


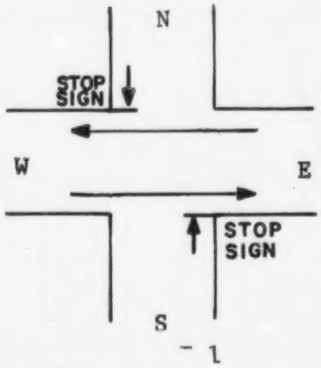
Figure 32. CO concentration contribution from excess emissions on approach 1 as a function of number of lanes and queue length



(vi) As with the uninterrupted flow location, the receptor should be located at the centerline of the adjacent sidewalk or at the right-of-way limit if no sidewalk exists.

Examples - Three examples illustrating the above principles are shown.

EXAMPLE 1



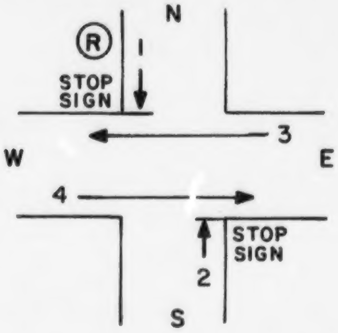
Given the following data:

Road segment	N	S	E	W
No. of approach lanes	1	1	1	1
Peak hour volume per lane	300	200	500	500
Average cruise speed (assume intersection in an outlying business district)	25	25	25	25

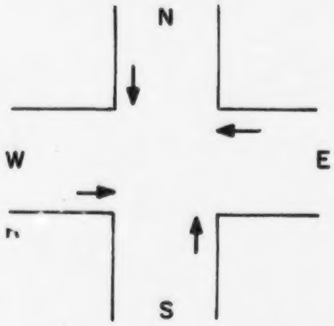
W-E roadway has uninterrupted flow. N-S roadway flow is controlled by a stop sign.

Solution:

Criterion (i) requires that the receptor be located on the N-S roadway. Since both N and S approaches have an equal number of lanes (1), the receptor should be located on the N approach according to criterion (ii). The traffic streams are then assigned identification numbers as depicted below according to criterion (v).



EXAMPLE 2

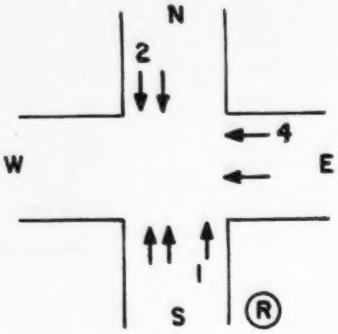


Road segment	N	S	E	W
No. of approach lanes	2	3	2	0
Peak hour volume per lane	500	600	500	-
Average cruise speed	25	25	25	-

Intersection controlled by a signal.

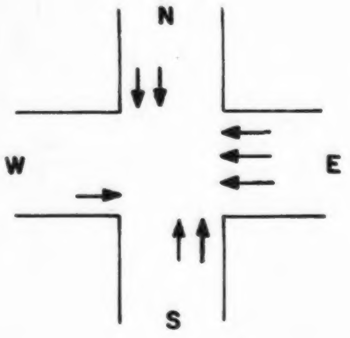
Solution:

The road segment having the greatest number of approach lanes (segment S) also has the highest peak hour lane volume. Hence, the receptor should be located on segment S based on criterion (iii) and the traffic streams identified as shown below.



Note: Since the crossroad (E-W) is a one-way street, segment W has no approach lanes and need not be considered in the subsequent analysis. However, segment E is still assigned the No. 4 identification number due to its relative position with respect to approach No. 1 (segment S).

EXAMPLE 3



Road segment	N	S	E	W
No. of approach lanes	2	2	3	1
Peak hour volume per lane	800	900	600	600
Average cruise speed	35	35	35	35

Intersection controlled by a signal.

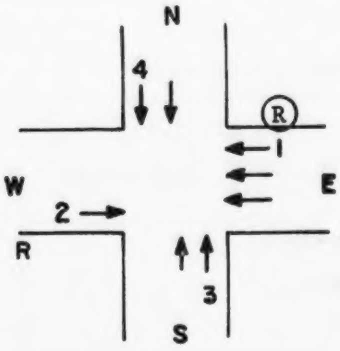
Solution:

Since the road segment having the greatest number of approach lanes (segment E) does not have the greatest lane volume (segment S), a test must be made according to criterion (iv) to determine the location of the highest expected CO concentration.

(a) First designating approach E as the main road: Vmain = 600 and Vcross = 900. Enter Table 5 at cruise speed 35 and the appropriate lane volumes. The resulting queue length, Le, on approach E is 231.0 m. Enter Figure 32 at Le = 231 m and read the $(\chi u/Q)e$ value at the intersection of Le = 231 and "3-lanes" line or calculate the $(\chi u/Q)e$ value from the appropriate equation. In this case, the equation must be used, so $(\chi u/Q)e = 785 \log (Le) - 610$ for a 3-lane approach and $(\chi u/Q)e = 1245.4$ in this case.

(b) Next designate approach S as the main road: Vmain = 900 and Vcross = 600. Again use Table 9 to determine the queue length on approach S (283.9 m). Enter Figure 32 at Le = 283.9 m and read the value of $(\chi u/Q)e$ at the intersection of Le = 283.9 and the "2 lanes" line or calculate the value from the equation. Once again, the equation must be used: $(\chi u/Q)e = 575 \log (Le) - 400$ for a 2-lane approach and $(\chi u/Q)e = 1010.6$ in this case.

(c) The $(\chi u/Q)e$ value is maximized by locating the receptor on segment E. The traffic streams approaching the intersection should be identified as depicted below.



2. Cruise Speed

It is recognized that travel speed data are not always readily available and that the effort required to actually measure travel speed is rather substantial. Offered here are alternative methods for deriving reasonable (in the context of hot spot analysis) estimates of cruise speed for various types of roadways. These methods involve a rather subjective process of defining speed as a simple function of lane volume. Figures 33 and 34 present specific speed-lane volume relationships that may be used for estimating cruise speeds on free-flowing sections of expressways at rural arterial streets. Table 9 provides suggested ranges of speeds for urban streets in several settings. Again, the speed estimates derived from these should be used only in the absence of measured data.

3. Cold Starts

It is likely that information regarding the percentages of vehicles operating in the cold mode will not be directly available for most areas; therefore, this parameter must be estimated. A study[9] of the percentages of vehicles operating in the cold mode at 60 locations in two major U.S. cities provides the basis for the following general guidance for estimating the fraction of cold operating vehicles as a function of facility type and location.

Location and street type	Range of percent of vehicles[*] operating in the cold-start mode
• CBD and fringe area; all facilities	40 to 70 percent
• Outer areas; arterials, collectors, locals	30 to 60 percent
• Core area expressways	15 to 30 percent
• Outer expressways	0 to 20 percent
• Indirect sources	40 to 60 percent

[*] Reflects afternoon peak travel hour conditions.

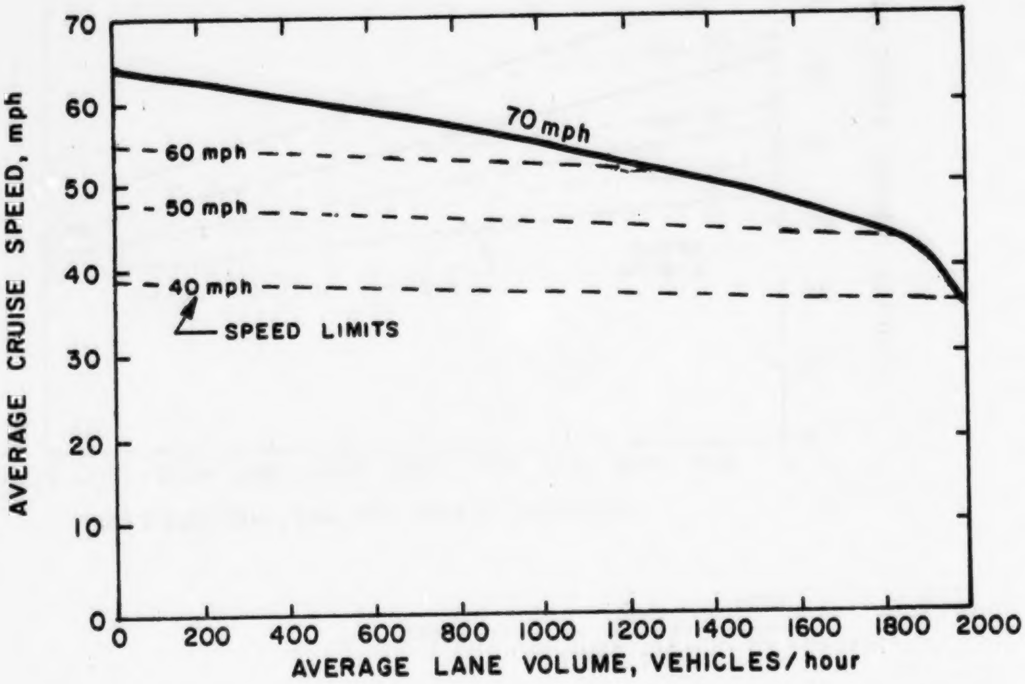


Figure 33. Typical relationships between average lane volume and average speed in one direction of travel on controlled access expressways under uninterrupted flow conditions[1]

Note: Minimum design standards for controlled access expressways typically specify design speeds of 70 mph or higher. It should be emphasized that design speed is used to establish minimum geometric standards to provide a factor of safety in comparison to the legal speed limits which control vehicle operation.

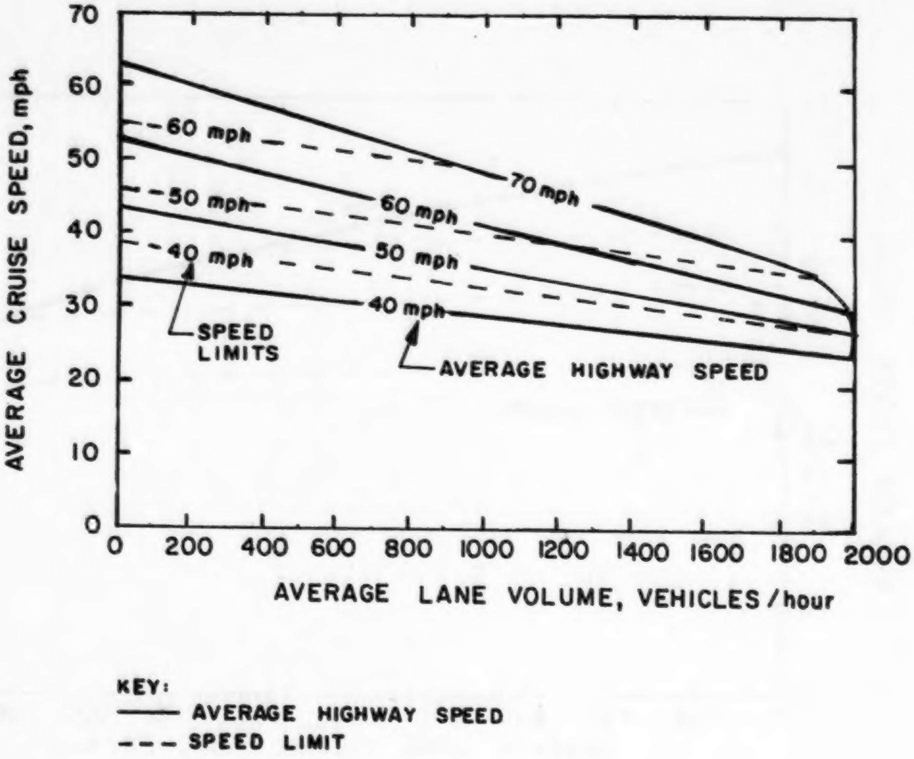


Figure 34. Typical relationships between average lane volume and average speed in one direction of travel on multilane rural highways under uninterrupted flow conditions[1]

Note: Average Highway Speed is the maximum speed at which a driver can comfortably travel over the stretch of roadway under favorable weather and zero volume conditions and maintain safe vehicle operation. Here again the Average Highway Speed represents the roadway design speed. (The legal speed limit cannot be higher than the Average Highway Speed.)

Table 9. CRITERIA FOR SELECTION OF CRUISE SPEED VALUES FOR URBAN ROADWAYS AND INTERSECTIONS

General location	Operating characteristics	Cruise speed range, mph
Central business district; Fringe business district	Much interference and friction from pedestrians or parking and unparking vehicles; closely spaced intersections; individual vehicle speed nearly always controlled by speed of the entire traffic stream	15 - 20
Outlying business district; Dense residential/ commercial land use	Occasional interference and friction from pedestrians or parking and unparking vehicles; nearby intersections occasionally restrict flow; individual vehicle speed somewhat controlled by speed of entire traffic stream	20 - 30
Outlying and residential residential/commercial land use	Infrequent interference or friction from pedestrians or maneuvering vehicles, no interference form downstream intersections; speed of individual vehicle mildly influenced by speed of traffic stream	25 - 35

D. EXAMPLE

An example of the hot spot verification procedure for a signalized intersection, School Street at Lexington Street, is presented here. This example makes use of Worksheet No. 5, Calculation of CO Concentration at Intersections. A completed worksheet is presented in Figure 35. Figure 36 provides a sketch of the intersection indicating the orientation of the approaches and the location of the optimum receptor site.

The first six entries are concerned with recording the data required to perform the hot spot verification. The Lexington Street north approach has the highest volume; thus, the optimum receptor site is positioned along this approach. The G/Cy of 0.53 for the Lexington Street approach is recorded in line 7.b.i and used with the approach volume, 455, to compute the effective crossroad volume of 330 vehicles per hour. These two volumes are entered on the appropriate section of Table 5 to determine the queue length (line 8).* The free flow emission rate is found in Table 6 for each approach and entered on line 9. For this example, the queue length is 41m, and the free flow emission rates in g/m-sec are 0.00392, 0.00278, 0.00227, and 0.00248 for the four approaches.

The normalized concentrations are found using curves in Figure 28, as appropriate and entered in line 10. The distance correction factors, line 12, are obtained from Figure 31 at the appropriate roadway/receptor separation distance for the Main Road approaches only; the correction factor for the cross-street approaches equals 1.0. Since the emission rates provided in the verification represent a specific set of assumptions regarding calendar year, vehicle, type distribution, cold- and hot-start percentages, etc., a correction factor must be applied to reflect actual conditions (i.e., the "assumed" actual conditions, which here, are those indicated in the heading data). This factor is determined using Table 8,

---

*These volumes are also used later with Table 5 to determine the excess emission rate.

WORKSHEET NO. 5 1 of 3

CALCULATION OF CO CONCENTRATIONS AT INTERSECTIONS

Location: School St. @ Lexington St. Waltham, MA Date: 21 May 1978

Analysis by: T. Milewski Checked by: TPM

Assumptions: Analysis Year: 1982.

Location: ____ California; X 49 State, low altitude;

____ 49-State, high altitude.

Ambient temperature: 20 °F.

Percent of vehicles operating in: (a) cold-start mode 10;

hot-start mode 20.

Vehicle-type distribution: LDV 78 %; LDT 11 %; HDV-G 6 %;

HDV-D 5 %; MC 0 %.

		Main road		Crossroad	
1.	Site identification	Lexington St.		School St.	
2a.	i - Intersection approach identification	1 N	2 S	3 E	4 W
2b.	- Is approach located in a street canyon	NO	NO	NO	NO
3.	n_i - Number of traffic lanes in approach i	1	1	1	1
4.	x_i - Roadway/receptor separation (m)	4	8		
5.	V_i - Peak-hour lane volume in each approach (veh/hr)	455	325	260	290
6.	S_i - Cruise speed (mph) on each approach	15	15	15	15
7. a.	Type of intersection (signalized or unsignalized)	SIGNALIZED			
b.	For signalized intersections:				
	i) $(G/Cy)_1$ - Green time/signal cycle ratio for approach 1	0.53			
	ii) V_{cross} - Effective crossroad volume (veh/hr)			330	
8.	Le - Queue length on approach 1 (m)	41			

Figure 35. Example Hot Spot Verification

	Main road		Crossroad	
9. Qf_i - Free-flow emission rate (g/m-sec)	0.00392	0.00276	0.00227	0.00248
10. $\frac{\chi u}{Q}_{f,main}$ - Normalized concentration contribution from free-flow emissions on main roadway (10^{-3} m^{-1})	380			
11. $\frac{\chi u}{Q}_{f,cross}$ - Normalized concentration contribution from free-flow emission on crossroad (10^{-3} m^{-1})			120	
12. Cdf_i - Distance correction factor, free-flow emissions	1.30	1.15		
13. C_{Ef} - Emissions correction factor, free-flow emissions.	1.33	1.33	1.33	1.33
14. a. $\chi_{f,main}$ - Concentration contribution from free-flow emissions on main road (mg/m^3)	4.2			
b. $\chi_{f,cross}$ - Concentration contribution from free-flow emissions on crossroad (mg/m^3)			0.8	
15. χ_f - Total concentration from free-flow emissions (mg/m^3)	5.0			
16. Q_e - Excess emission rate (g/m-sec)	0.02065			
17. $\frac{\chi u}{Q}_{e,i}$ - Normalized concentration contribution from excess emissions on approach i ($10^{-3}m^{-1}$)	320	85	40	20
18. Cde_i - Distance correction factor, excess emissions	1.25	1.35	1.0	1.0
19. C_{Ee} - Emissions correction factor, excess emissions	0.96	0.96	0.96	0.96
20. $\chi_{e,i}$ - Concentration contribution from excess emissions on approach i (mg/m^3)	9.6	2.8	1.0	0.5
21. χ_e - Total contribution from excess emissions (mg/m^3)	13.9			
22. $\chi_{E,1\text{-}hr}$ - 1-hour average concentration resulting from vehicle emissions (mg/m^3)	18.9			

Figure 35 (continued). Example Hot Spot Verification

23. $\chi_{E,\ 8\text{-hr}}$ - 8-hour average CO concentration (mg/m^3) 13.2

24. $\chi_{B,8\text{-hr}}$ - 8-hour average background concentration (mg/m^3) 3.6

25. $\chi_{T,8\text{-hr}}$ - Total CO concentration, 8-hour average (mg/m^3) 16.8

26. $\chi_{T,8\text{-hr}}$ - Total CO concentration, 8-hour average (ppm) 14.6

Figure 35 (continued). Example Hot Spot Verification

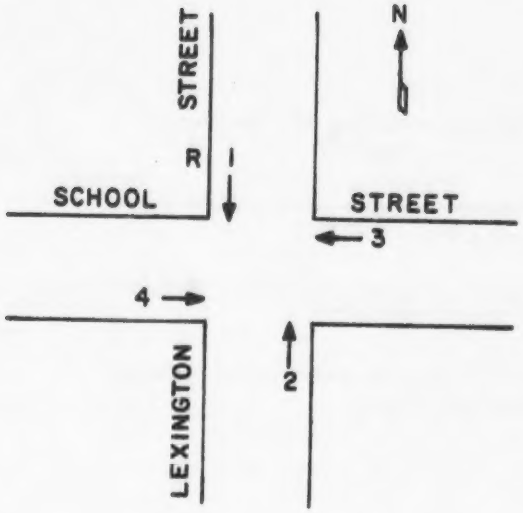

N
STREET
R
1
SCHOOL
STREET
3
4
LEXINGTON
2

Figure 36. Approach orientation and receptor (R) location

for 49-state, low altitude conditions and the conditions described in the heading data regarding analysis year, location, etc., for each vehicle type. The individual correction factors for each vehicle type are then weighted according to the actual percentages observed (or assumed) in the traffic stream, and a composite factor is derived. In this example, the individual correction factors from Table 8 are: 0.83, 2.85, 5.23, and 0.6 for LDV's, LDT's, HDV-G's, and HDV-D's, respectively. Weighting these according to the percentages of each type of vehicle (from the heading data) yields:

$$C_{Ef} = (0.78)(0.83) + (0.11)(2.85) + (0.06)(5.23) + (0.05)(0.6) = 1.33$$

The concentration contribution from free-flow emissions is computed separately for each approach for both the main street and the cross street. For the main street approaches, the free-flow concentration, $\chi_{f,main}$, is computed from the following equation:

$$\chi_{f,main} = \left[(\text{line } 10)(\text{line } 13)\right]\left[(\text{line } 3)_1(\text{line } 9)_1(\text{line } 12)_1 + (\text{line } 3)_2(\text{line } 9)_2(\text{line } 12)_2\right] = \left[(380)(1.33)\right]\left[(1)(0.00392)(1.3) + (1)(0.00278)(1.15)\right] = 4.2 \text{ mg/m}^3$$

For the cross-street contribution:

$$\chi_{f,cross} = \left[(\text{line } 11)(\text{line } 13)\right]\left[(\text{line } 3)_3(\text{line } 9)_3 + (\text{line } 3)_4 (\text{line } 9)_4\right] = \left[(120)(1.33)\right]\left[(1)(0.00227) + (1)(0.00248)\right] = 0.8 \text{ mg/m}^3$$

The total contribution, χ_f, from free-flow emissions is:

$$\chi_f = \chi_{f,main} + \chi_{f,cross} = 4.2 \text{ mg/m}^3 + 0.8 \text{ mg/m}^3 = 5.0 \text{ mg/m}^3$$

The next step is to compute the excess emissions correction factor. This factor is derived in the same manner that the free flow emissions correction factors are developed, except a speed of 0 mph is used in Table 8. The excess emissions correction factor thus derived is 0.96.

The excess emission rate, Q_E, is computed indirectly using cruise and queue component emission rates found in Table 5, and appropriate correction factors. The cruise component, Q_{QC}, and the total queue component, Q_{QT}, are obtained from Table 5 based on the highest main road volume of 455 vehicles (from line 5 on the Worksheet), and the effective crossroad volume of 330 vehicles (from line 7.b.ii. of the Worksheet). The correction factors applied to Q_{QC} and Q_{QT} are the free flow emissions correction factor, C_{Ef} (from line 13 of the Worksheet), and the excess emissions correction factor, C_{Ee} (from line 19 of the Worksheet), respectively. The actual excess emission rate, Q_E, is then computed by:

$$Q_e = (Q_{QT})(C_{Ee}) - (Q_{QC})(C_{Ef}) =$$
$$(0.02302)(0.96) - (0.00221)(1.33) = 0.01916$$

The normalized concentration contribution from excess emissions for each approach is determined using Figures 25 and 26, and distance correction factors are computed for the main street approaches using Figure 30. The above data are used to compute the excess emissions contribution for each approach, χ_{ei}, from:

$$\chi_{ei} = (Q_e)\left(\frac{\chi n}{Q}\right)_{ei} (Cde)_i$$

The total concentration from excess emissions, then is:

$$\chi_e = \sum_{n-1}^{4} \chi_{ei}$$

In this example, χ_e was found to be 11.1 mg/m^3. The total 1-hour average concentration, then, is:

$$\chi_f + \chi_e = 5.0 + 11.1 = 16.1 \text{ mg/m}^3$$

The 8-hour average CO concentration is computed as the product of 16.1 (the 1-hour average) and 0.7 (a correlation factor), which yields 11.3 mg/m^3; this value is recorded on line 23. The 11.3 mg/m^3 concentration is the local traffic contribution to which a background concentration, 2.9 mg/m^3, is added to determine the total 8-hour average CO concentration, which is 14.2 mg/m^3. To convert the concentration from mg/m^3 to ppm, 14.2 mg/m^3 is multiplied by 0.87, which yields 12.4 ppm; this is entered on line 29.

The results of the verification indicate a hot spot potential at the Lexington Street - School Street intersection. The highest likely 8-hour average CO concentration computed for the north approach of Lexington Street is 16.8 mg/m^3 (14.6 ppm).

SECTION IV

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16. ABSTRACT

This report presents a summary of the guidelines for the identification and evaluation of localized violations of carbon monoxide air quality standards in the vicinity of streets and highways. The guidelines are provided to facilitate the rapid and efficient review of CO conditions along existing roadway networks, without the need for extensive air quality monitoring, and are based upon the use of limited traffic data. Two stages of review are provided for. Preliminary screening, performed with simple nomographs included herein, simply identifies those locations with the potential to violate CO standards; no quantitative estimate of CO concentrations results from preliminary screening. Verification screening, using procedures and forms provided herein, allows for consideration of additional site-specific conditions and provides quantitative estimates of maximum CO concentrations. Both screening procedures are performed manually and are based upon the EPA Indirect Source Review Guidelines. Data collection procedures, computation techniques, and forms are recommended, and examples are provided. A more comprehensive explanation of the guidelines in terms of their development, technical basis, capabilities and limitations is provided in Volume I.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Atmosphere Contamination Control Atmospheric Models Carbon Monoxide Exhaust Gases Traffic Engineering Transportation/Urban Planning	Air Pollution Model Automobile Exhaust Highway Corridor Air Quality Analysis Relationships between Traffic and Nearby Air Quality	13/13B
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